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...NEERING, NOVEMBER 28, 1924.

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ENGINEERING:

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VOL. CXVIII.—No. 3074.] LONDON: FRIDAY, NOVEMBER 28, 1924. [Registered at the General Post Office as a Newspaper.] [PRICE ... 1s. BY FOREIGN POST 1s. 3d.

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PATENT WATER-TUBE BOILERS.
AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

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OF ALL DESCRIPTIONS.
FLOATING CRANES. COAL BUNKERING VESSELS.
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Agents: MARINE WORKS, LTD., FRIARS HOUSE, 39-41, NEW BROAD ST., LONDON, E.C.2.
Six half-page Advert. last week and next week. 2087

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STEEL TANKS, PIPES, GASHOLDERS, &c.
Thos. Piggott & Co., Limited,
BIRMINGHAM. 1241
See Advertisement last week, page 19.

Spencer-Hopwood & Kirke
PATENT BOILERS See Page 49. 1994
Sole Makers: SPENCER-BONECOURT, LTD., Parliament Mansions, Victoria St., London, S.W.

Tank Locomotives.
Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO. LTD., ENGINEERS, NEWCASTLE-ON-TYNE. 1864

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Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 2257
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HEAD OFFICE: 34, Robertson Street, Glasgow.
See Advertisement, page 33, Nov. 21.

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PASSENGER AND CARGO STEAMERS.
SHALLOW DRAFT VESSELS. 2276

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Worm Wheels cut up to 13 ft. diam.
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PRESSURE, AIR, STEAM
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Naval Outfits a Speciality,
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GENERATING SETS, Totally Enclosed, Three Crank Self-Lubricating Engine, with Complete Condensing Plant, by Allens, Pipes, Valves, Oil Separator, Etc., complete.
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Fresh Water Distillers.
Main Feed Pumps.
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Auxiliary Surface Condensers,
&c., &c. 2327

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AND
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See Advertisement, page 58. 1872

Peter Brotherhood Ltd.,
PETERBOROUGH.
STEAM ENGINES AND TURBINES.
GAS AND OIL ENGINES.
AIR COMPRESSORS.
REFRIGERATING PLANT. 1475
See Advertisement, page 53, Nov. 21.

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IN WHOLE OR PLOTS.
GROUND extending to 42,672 square yards, and BUILDINGS thereon of Engine and Boiler Shops (lately belonging to Messrs. DUNSMUIR & JACKSON, Ltd.), equipped with Overhead Travelling Cranes up to 60 tons.
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London Office: Od 6353
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Yorkshire Engine Co., Ltd.,
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Railway, Colliery, Mining and General Engineers, are PREPARED
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Address confidential enquiries to the SECRETARY. 2404

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Telegrams: "Epa," London.
Telephone: 7424 Central.
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CHARTERED PATENT AGENTS,
306, High Holborn, London, W.C.1. 585
PATENTS. DESIGNS. TRADE MARKS.

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ENGINEERS, IRLAM, MANCHESTER.
FEED WATER HEATERS, CALORIFIERS, EVAPORATORS, CONDENSERS, AIR HEATERS, } NOW'S PATENTS,
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SYPHONIA STEAM TRAPS, REDUCING VALVES.
High-class GUNMETAL STEAM FITTINGS.
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LAND AND MARINE
YARROW BOILERS. 2277

Matthew Paul & Co., Ltd.
LEVENFORD WORKS, Dumbarton. 2913
See Full Page Advt., page 59, Nov. 7.

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Walter Somers, Limited,
HALESOWEN. 7116

Taylor & Challen Presses
For Production of SHEET METAL WORK, COINAGE, CARTRIDGES AND GUNPOWDER.
Foundry, Works and Showrooms: BIRMINGHAM.
See Advert., page 57, Nov. 7. 3195

Railway Switches and Crossings.
T. SUMMERSON & SONS, LIMITED,
DARLINGTON. 2006

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VALVE CROSS COMPOUND CONDENSING ENGINE, by Burnley Ironworks.
Cylinders 14 in. and 28 in. by 36 in. stroke.
Corliss valves to inlet and exhaust of both cylinders.
Belt Flywheel 16 ft. by 26 in.
Vertical Air Pump and Condenser, below floor level.
Worked by L. Crank from L.P. Crosshead.
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Cylinders 11 in. and 20 in. by 30 in. stroke.
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Rope Flywheel, 12 ft. dia.
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Special designs only.
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The Manchester Steam Users ASSOCIATION.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.

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Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 2005

Sir John Wolfe Barry and PARTNERS DESIRE to GIVE NOTICE

that Mr. F. C. DUNCAN. formerly of Sheffield, is no longer employed by them, and is not authorised to represent either their firm or the Bengal-Nagpur Railway Company in any connection whatever. G 532

PATENTS AND DESIGNS ACTS, 1907 AND 1919.

Notice is Hereby Given that

Aktiebolaget Ljungströms Angturbin, a Swedish Company, of Asenalsgatan 2, Stockholm, in the Kingdom of Sweden, Manufacturers, seek leave to amend the Specification of Letters Patent No. 162250 granted to them for "Improvements in Apparatus for Effecting the Transfer of Heat between Liquids and Gases.

Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents) issued on the 19th November, 1924.

Any person, or persons, may give notice of Opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton Buildings, London, W.C.2, within one calendar month from the date of the said Journal.

W. TEMPLE FRANKS,
Comptroller-General.

HERBERT HADDAN & CO., Chartered Patent Agents, 31 & 32, Bedford Street, Strand, W.C.2. G 495

The Norton & Gregory Annual SCHOLARSHIPS in ENGINEERING.

(Third Year.)
Offered by
NORTON & GREGORY Ld., London.

HONORARY COMMITTEE.

SIR JOSEPH PETAVEL, K.B.E., D.Sc., F.R.S., Director of the National Physical Laboratory, Teddington, Chairman.

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Professor E. G. COKER, D.Sc., F.R.S., Dean of Faculty of Engineering, University of London, University College, Gower Street, W.C.1.

J. TALBOT, Esq., T.D., M.A., B.Sc., Master of Haileybury College, appointed by the Committee of the Headmasters' Conference.

G. H. BURKHARD, Esq., M.A., M.Sc., Principal of Swindon and North Wilts Secondary School and Technical Institution, Swindon, appointed by the Incorporated Association of Headmasters.

Rev. S. CLAY, Esq., D.Sc., Principal of Northern Polytechnic Institute, London, appointed by the Association of Principals of Technical Institutions.

Together with
the CHAIRMAN and the MANAGING DIRECTOR of Messrs. NORTON & GREGORY Ld.

Messrs. NORTON & GREGORY Ld. OFFER TWO ENGINEERING SCHOLARSHIPS to be competed for annually, one value £100 per annum and one value £50 per annum, tenable for three years at any University in the United Kingdom or British Dominions approved by the Committee.

A sum sufficient to cover the scholarships now offered has been deposited by the donors in the names of the Chairman and Vice-Chairman of the Committee.

Candidates must have reached the age of 17, but not the age of 19, on 1st March in the year of examination, be domiciled in the United Kingdom, and undertake to pursue a three years' course in engineering with a view to following it as a profession.

Papers, which will cover two days' examination, will be set in the following four subjects:

ENGLISH.
MATHEMATICS.
MECHANICS,
GENERAL PHYSICS.

The examination for the 1925 scholarships will be held on 5th and 6th March, and all application forms must reach the Committee not later than the last day of January, 1925.

The scholarship awards will be officially published on 15th May, 1925.

Full particulars and official application forms may be obtained from the SECRETARY Scholarships' Committee, Messrs. NORTON & GREGORY Ld., 1 and 2, Castle Lane, Westminster, London, S.W.1. G 497

Correspondence Courses for

Inst. Civil Engrs., Inst. Mech. E., London Univ. (Matric., Inter., B.Sc.), Inst. M. & Cy. E., and ALL ENGINEERING EXAMINATIONS personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours) Eng. London, Assoc. M. Inst. C.E., Chartered Civil Engineer, M.R.S.I., F.R.S.A., etc. Also Day Tuition in Office. Excellent results at all Exams., comprising hundreds of successful Students. Courses may commence at any time, and all Students receive individual tuition.—For full particulars apply to 8/11, TRAFFORD CHAMBERS, 58, SOUTH JOHN STREET, LIVERPOOL. 1993

Engineering Salesmanship

and SALES MANAGEMENT.—Write for brochure describing our special Course of Training for posts of unlimited scope in this lucrative field.—DIRECTOR, Institute of Engineering Salesmanship, 338, Oxford Road, Manchester. 2431

TENDERS.

DUBLIN PORT AND DOCKS BOARD.

The Dublin Port and Docks Boards is prepared to receive

Tenders for the Supply of

about 13½ tons of FLAT BOTTOMED STEEL RAILS, complete with Fishplates.

Drawing and particulars can be obtained at the Engineer's Office, East Wall, Dublin, between the hours of Ten a.m. and Four p.m.

Tenders endorsed on the outside "Tender for Rails," should be delivered to the SECRETARY, Port and Docks Office, Westmoreland Street, Dublin, not later than 11th December, 1924.

The Board does not bind itself to accept the lowest or any Tender.

Port and Docks Office,
19th November, 1924. G 492

BENGAL-NAGPUR RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive

Tenders for 25 Open and 75 COVERED GOODS BOGIE WAGONS,

2 ft. 6 in. Gauge.

Specification and Form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad Street, E.C.2, on or after 21st November, 1924.

A fee of 20s. will be charged for the specification, which is NOT returnable.

Tenders must be submitted not later than NOON on Wednesday, 3rd December, 1924.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. C. VOLKERS,
Secretary. G 485

BOMBAY BARODA AND CENTRAL INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Wednesday, 10th December,

Tenders for the Supply of :—

(1) STEEL MATERIAL,

and up to Noon on Wednesday, 17th December, Tenders for :—

(2) COVERED GOODS WAGONS.

Tenders must be made on forms, copies of which, with Specification, can be obtained at these Offices on payment of 20s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices: 91, Petty France,
Westminster, S.W.1.
24th November, 1924. G 521

HAYFIELD RURAL DISTRICT COUNCIL.

MELLOR WATERWORKS.

The Hayfield Rural District Council invite

Tenders from Contractors for

PROVIDING AND LAYING about 7¾ miles of 6in., 5in., 4in. and 3in. CAST IRON PIPES, with all necessary Valves, Hydrants and Apparatus, and also for CONSTRUCTING TWO MASS CONCRETE TANKS at Hayfield and Mellor respectively.

The Drawings and Specifications may be seen at the Office of the Surveyor to the Council at Hayfield, Derbyshire, by previous appointment, or at the Offices of the Engineers, Messrs. G. & F. W. HOBSON, M.Inst.C.E., M.Cons.E., Bank Chambers, Loughborough, from whom copies of the Schedules of Quantities may be obtained on deposit of Cheque for £5 5s., which will be refunded to Contractors making a *bona fide* Tender, on the return of the documents to the Engineers.

Sealed Tenders on the form supplied, endorsed "Tender for Mellor Waterworks," are to be sent to the undersigned not later than Monday, the 15th day of December, 1924.

The Council do not bind themselves to accept the lowest or any Tender.

J. R. BOWDEN,
Clerk to the Council.

Council Offices,
High Street, New Mills,
via Stockport.
17th November, 1924. G 447

GOVERNMENT OF BRITISH GUIANA.

CITY OF GEORGETOWN MAIN DRAINAGE, 1924.
SEWAGE PUMPING MACHINERY.

Tenders are Invited by

Messrs. J. L. WILD & COMPANY, LIMITED, of 180, Piccadilly, W.1, for the SUPPLY and DELIVERY f.o.b. of the necessary ELECTRIC GENERATING PLANT, direct coupled to Crude Oil Engines (adapted for alcohol burning) complete with Switchgear, Overhead Transmission Lines and Fifty Vertical type ELECTRIC MOTORS and PUMPS, the latter to be suitable for pumping unscreened crude sewage.

Drawings and Specifications may be inspected by intending Contractors at the Offices of Messrs. HOWARD HUMPHREYS & SONS, Consulting Engineers to the Government, at 28, Victoria Street, Westminster, between the hours of Ten a.m. and Four p.m. (except Saturdays) from Thursday, December 4th, to Tuesday, December 16th, 1924, inclusive.

Intending Contractors will be required to deposit the sum of Ten Guineas prior to their being supplied with particulars. This deposit will be returned upon receipt of a *bona fide* Tender.

Messrs. J. L. WILD & COMPANY, LIMITED, do not bind themselves to accept the lowest or any tender.

Tenders and layout drawings will be required to be deposited with Messrs. J. L. WILD & COMPANY, LIMITED, by the first post on January 17th, 1925, and should be marked "Sewage Pumping Machinery." G 512

BOROUGH OF SHREWSBURY.

RECONSTRUCTION OF THE ENGLISH BRIDGE OVER THE RIVER SEVERN.

The Corporation Invite

Tenders from Public Works

Contractors experienced in the erection of Masonry Bridges, for the RECONSTRUCTION of the ENGLISH BRIDGE.

The works include the taking down an re-building of the existing masonry in order to reduce the gradient and widen the structure, together with the improvement of the approaches, etc.

Copies of Plans, Specification, Bill of Quantities, and Conditions of Contract may be obtained on application to the Engineer, Mr. A. W. WARD, Assoc. M. Inst. C.E., Borough Surveyor, at the Guildhall, accompanied by a bank note for £10 which will be returned on receipt of a *bona fide* Tender and all Plans and documents loaned for the preparation thereof.

Sealed Tenders on the official form, suitably endorsed, and the Bill of Quantities (under separate cover) fully priced out, must reach me by Ten a.m. on Monday, the 15th December, 1924.

The Corporation do not bind themselves to accept the lowest or any Tender, nor will any allowance or payment be made for the preparation and submission of a Tender.

R. F. PRIDEAUX,
Town Clerk.

Guildhall,
Shrewsbury.
November 17, 1924. G 536

THE DIRECTOR-GENERAL, INDIA STORE DEPARTMENT, Branch No. 16, Belvedere Road, Lambeth, S.E.1, invites

Tenders for :—

2074 RAILWAY WAGONS.

Tenders are being called for simultaneously in India.

Tenders due on the 13th January, 1925.

Tender form obtainable from above. G 530

BELFAST CORPORATION.
ELECTRICITY DEPARTMENT.

The Belfast Corporation invite

Tenders for the Supply,

DELIVERY and ERECTION of—

SPECIFICATION "W 31"—STEEL FRAMEWORK for Internal Office Building.

Specification, with Form of Contract, may be obtained from Mr. JOHNSTONE WRIGHT, City Electrical Engineer and Manager, East Bridge Street, Belfast, on deposit of Two Guineas. This deposit will be refunded provided a *bona fide* Tender has been sent in and not withdrawn. Extra copies may be obtained at One Guinea each, which sum will not be returnable.

Sealed Tenders, endorsed "Tender for Steel Framework, Electricity Department," to be lodged at my Office not later than Ten a.m., on Monday, 15th December, 1924.

Persons Tendering must comply with the Council's Standing Orders relating to wages, hours of labour, extras, etc.

The lowest or any Tender not necessarily accepted.

An official receipt must be obtained for every Tender delivered by hand. Tenders sent by post must be registered.

E. MEYER,
Town Clerk.

24th November, 1924. G 520

APPOINTMENTS OPEN.

OVERSEAS.

CAPE TECHNICAL COLLEGE, CAPE TOWN.

Applications are Invited for

a LECTURER in the Engineering Department.

Graduate with workshop and drawing office experience, evidence of teaching ability, to teach Engineering Drawing, Heat Engines, Mechanics and Electrotechnics. Other special technical qualifications and experience may be taken in lieu of a degree or diploma. Salary £400–25–500.

The successful candidate must submit a certificate of health, conditions of service may be had on application to the undermentioned.

Applications, in duplicate, must be mentioned with certified copies of testimonials giving evidence of workshop experience, teaching ability, technical qualifications and stating age of applicant, before the 8th December, 1924.

Applications to be sent to :—

CHALMERS, GUTHRIE & CO., LTD.,
9, Idol Lane,
London, E.C.3. G 457

Representative Required.—

GENTLEMAN with good connection amongst Gas and Chemical Works, &c., in Scotland, REQUIRED to increase existing connection of well-known Glasgow Engineering Firm and obtain orders for Structural Work, Gas Plant, Oil Storage and Refinery Plant, &c.—Apply, in writing, stating qualifications and salary required, to MANN, JUDD, GORDON & CO., 142, St. Vincent Street, Glasgow. G 345

Rate Fixer Required for

Midland District. Familiar with small work and laying out sequence of operations and quick methods of production. State age, experience and salary required.—Address, G 378, Offices of ENGINEERING.

Works Manager to Take

charge of engineering works and foundry, about 500 hands, steam turbines, steam engines, and refrigerating machinery. Dane preferred.—Address, giving full particulars of past experience, to ATLAS COMPANY, LTD., Copenhagen, L. G 421

Manager Wanted with Ex-

perience in general engineering and mechanical handling plant, also modern foundry practice; must be capable designer. Applications treated in confidence.—Address, stating experience (in detail), age and salary expected, G 438, Offices of ENGINEERING.

Wanted, First-class Man for

important executive position in large engineering works. Must be experienced toolmaker with good technical training in modern tool designing for mass production.—Address, TOOLS, WM. PORTEOUS & Co., Advertising Agents, Glasgow. G 506

PORTSMOUTH WATER COMPANY.

ENGINEERING ASSISTANT.

Permanent Engineering

ASSISTANT, about 25 to 30 years of age REQUIRED by the Borough of Portsmouth Waterworks Company, as early as possible in the new year. Applicants must have a good knowledge of Waterworks design and construction, both practical and theoretical, and must also be good Surveyors and Draughtsmen. Previous personal experience in Waterworks maintenance, including pumping machinery, would be an advantage, and an Associate Member of the Institution of Civil Engineers would be preferred. Salary £350 per annum, rising annually, by £25 to £450.—Applications on Forms which will be provided on application to the ENGINEER and GENERAL MANAGER, Waterworks Company, Portsmouth, must be delivered not later than Friday, December 12th, next. G 351

Technical Assistant.—Wanted,

by London Firm of Shipowners, TECHNICAL ASSISTANT for Office. Experience of Steam and Internal Combustion Machinery essential; some knowledge of repair work desirable.—Apply, by letter, stating age, full details of experience and salary required, copies of testimonials must be enclosed, CAPABLE, c/o Advertisement Department, 5, New Bridge Street, London, E.C.4. G 500

Wanted, Sales Engineer,

young, energetic, fully conversant with theory and practical installation of small Rotary Pumping Installations.—Address, G 487, Offices of ENGINEERING.

Waterworks Engineer,

WANTED, for large Waterworks in Scotland with large scheme in hand a TEMPORARY ASSISTANT, with good experience of pipelaying and concrete work and contractor's final measurements. Salary £330. Send chronological statement of experience, state of health, age and testimonials.—Address, G 534, Offices of ENGINEERING.

Chief Engineer, with Wide

mechanical and electrical experience REQUIRED, for abroad, Scotsman preferred. Should speak Spanish and be capable of taking complete charge of large Factory with steam pumps, air compressors, centrifugals, etc., steam-electric Power House, Foundry Machine Shop, Locomotives, etc.—Write stating age, nationality, qualifications, full details of previous experience, salary last received, and when disengaged, to Z.A. 139, c/o DEACONS' Advertising Offices, Leadenhall St., London. G 539

HIS EXALTED HIGHNESS THE NIZAM'S GUARANTEED STATE RAILWAYS COMPANY LIMITED.

THREE JUNIOR ASSISTANT ENGINEERS.

The Directors are prepared to receive

Applications (by Letter only)

from duly qualified candidates for APPOINTMENT to the above POSTS in India.

QUALIFICATIONS: Candidates must have had a good general and technical education, and have obtained a degree at a recognised Engineering College or passed the Associate Membership Examination of the Institution of Civil Engineers. In addition it is desirable that they should have had at least one year's practical experience with a Railway Company or on Public Works.

SALARY: Rs. 400–50–1000 per calendar month; commencing salary Rs. 400 to Rs. 500 according to age and experience.

TERMS: A three years' agreement in the first instance, first class free passage to India, and home again on satisfactory termination of service. Privilege leave and furlough in accordance with the Rules in force.

Applicants must send in to the undersigned a record of their career in chronological order (with dates) and COPIES ONLY of testimonials, Service Certificates, etc., giving name of firm where pupilage was served and of subsequent employers, with short details of work in each case, and with particulars of general and technical education, honours, etc., gained, not later than the 12th December, 1924.

F. ADAMS,
Secretary.

Offices of the Company :—
50, Old Broad Street,
London, E.C.2.
25th November, 1924. G 523

EAST INDIAN RAILWAY.

BRIDGE ENGINEER.

The Directors are prepared to receive

Applications from Properly

Qualified Candidates for APPOINTMENT as BRIDGE ENGINEER in the service of the Company in India.

AGE should not be more than 30 years.

QUALIFICATIONS: Applicants must be proficient in the design and manufacture of high class bridge-work, and some experience in the erection of such work is desirable. Candidates must have received a good general and technical education and preference will be given to one who has passed the A.M.Inst.C.E., or possesses a good degree from a recognised Engineering College or University.

SALARY: From Rupees 525 to Rupees. 1000 per calendar month, according to age, qualifications and experience, rising in accordance with the Company's Rules.

TERMS: A four years' agreement in the first instance, first class free passage to India.

The selected candidate will only be appointed subject to passing a strict medical examination by the Company's Consulting Physician.

Applicants must state whether they are married or single and give a detailed record of their career in chronological order, with dates, giving particulars of education, honours, etc., gained, and names of firms where apprentice-ship was served and subsequent experience with class of work in each case. Reference must be made to the qualifications set out above.

Applications (by letter only) should be addressed to the undersigned, together with COPIES ONLY of testimonials, etc., not later than the 6th December, 1924.

By Order,
G. H. LILLIE,
Secretary.

73–76, King William Street,
London, E.C.4.
21st November, 1924. G 505

A Large Iron and Steel

Manufacturing Firm REQUIRES the SERVICES of a FIRST-CLASS ENGINEER, to take charge of its Plant and Drawing Office. Preference will be given to a man accustomed to both modern and old plant and who has had considerable experience in the rapid and efficient repair of breakages.—Applications, which would be treated in confidence, together with experience and salary required, should be made to G 467, Offices of ENGINEERING.

Internal Combustion Engines.

—Experienced DRAUGHTSMAN DESIGNER WANTED. Must have sound knowledge of theoretical mechanics and latest practice in Diesel design and operation.—Address, by letter, stating qualifications, experience and salary required, to G 416, Offices of ENGINEERING.

Transformer Draughtsman.—

Applications are requested for the appointment of Transformer Draughtsman with well-known British firm of Electrical Engineers.

Applicants must have had first-class experience in the design and manufacture of LARGE HIGH TENSION TRANSFORMERS.

The position offers ample scope to a suitable man. Applications will be treated with strict confidence. —Address, giving full particulars of experience, G 388, Offices of ENGINEERING.

REPARATIONS AND THE BRITISH ENGINEERING INDUSTRY.

(From a Correspondent.)

II.—German Exports and Their Markets.

In the previous article it was contended that the carrying out of the Dawes Report involves the concentration of Germany upon production for export.

Apart from a general intensification of production, Germany will be bound to specialise in commodities which she is especially equipped by nature to produce. The Report emphasises in particular that she should not concentrate on commodities, a large part of the value of which represents materials previously imported. The object of this proviso is clearly to increase the favourable balance of trade in a greater ratio than the volume of trade. Its effect will be to make Germany a less valuable customer to us and to those of our customers who are involved with us in triangular trade with Germany. Secondly, it will compel Germany to select those of her industries best equipped for production for export and those the value of whose finished products are highest in proportion to the value of imported material employed in their manufacture, and to concentrate upon them to create her favourable balance of trade.

Bearing these general propositions in mind, it will be useful to consider what are the specific commodities fulfilling these requirements *par excellence*, and also in what markets Germany can sell them. Owing to the dislocation caused by the collapse of the mark, official figures for German trade values tend to be unreliable. Accordingly, in Table I below the volume of German trade is given for the years 1913 and 1922 :—

Table I.—*Thousands of Metric Tons.*

—	Imports.		Exports.		Net Imports.	
	1913.	1922.	1913.	1922.	1913.	1922.
Raw materials and semi-manufactured goods ..	59,701	38,877	59,026	14,272	675	24,605
Manufactured goods	1,249	1,894	9,321	5,836	−8,072	−3,942
Food	11,700	5,074	5,368	1,443	6,332	3,631
Living animals ..	180	30	2	5	178	25
Totals	72,830	45,875	73,717	21,556	− 887	24,319

With the unimportant exception of "living animals" there is a great decline in all classes of German exports. There is a heavy adverse balance in food. With regard to fuel, which was before the war one of Germany's most important raw material exports, some development may be expected of her lignite production, but the cession of her coal-bearing territories under the treaty, coupled with her own increased requirements for industrial purposes, will reduce her competitive power in this direction. The same applies in a less degree to raw iron and steel.

For the purposes of this inquiry the outstanding conclusion to be drawn from the above figures is that it is only in the category of manufactured articles that any résilience is shown. In 1913 the five principal groups of German manufactured goods exported were :—

	Per Cent. of Total Values.
Iron products	15·8
Machinery	11·2
Textiles	12·7
Chemicals and Dies	9·4
Leather goods	5·4

Iron products and machinery in 1913 were, roughly, three-tenths of the total; in 1920 they were three-eighths. The Report of the British Commercial Secretary for Occupied Territories states :—"One of the chief results of the post-war re-grouping of the iron and steel industries which has proceeded in Germany is that she is no longer interested in the export of pig-iron and semi-manufactured steel as before the war; her pig-iron and steel production goes to feed her own industries in producing a finished article of higher value." In other words, the increased percentage of these two categories from three-tenths to three-eighths has been at the expense of the iron products and by concentration on machinery.

The market for chemicals and dyes is limited a great expansion in that category of exports is not to be looked for. Leather goods and textiles are peculiar in that a large percentage of the value of the finished article represents material previously imported.

Precisely the opposite is the case in the category of machinery. Here Germany's need for imported material is at a minimum. Her technical skill and equipment are of the highest order, and the value of the finished product is extremely high in relation to the raw material costs. The conclusion is that it will be to an expansion of machinery production for export that Germany will turn primarily, to increase her trade balance and make possible the payment of reparations, though there will, no doubt, be a smaller increase in most of her principal commodities.

To assess the effect of such an expansion in terms of competition, we must turn to German machinery export figures in greater detail. The export of machinery and locomotives from Germany in 1923 showed a considerable falling off, as these industries are to a large extent situated in the Ruhr or dependent on that district for the supply of semi-manufactures. The following are the official figures for the main categories :—

Table II.—*German Engineering Exports.*

	1913.	1922.	1923.*
	Metric tons.	Metric tons.	Metric tons.
Textile machines, including parts	75,014	42,643	45,191
Locomotives and tenders ..	54,445	101,250*	17,163
Tool machinery	90,279	78,167	49,762
Agricultural machines	40,708	34,411	26,686
Other machines	277,705	198,104	142,812
Electrical machines and parts	41,882	23,697	26,937

* Not too much reliance can be placed on any of the official figures for the year 1923, owing to dislocation due to the Ruhr episode. The great decline in locomotives is said to be due chiefly to the absence of Russian orders.

Even at the reduced proportions shown in Table II., it will be admitted that German competition during 1922 and 1923 has been extremely severe. It is to be expected that the economic evacuation of the Ruhr, following the Dawes Report, will result in an immediate boom in these trades. If this boom is maintained and an expansion of export trade takes place on the scale contemplated above, it is evident that German competition must attain to very serious proportions.

If the foregoing indicates the general bearing of the Dawes scheme upon the German engineering industry, there is one provision of the plan which demands further attention, viz., the Industrial Bonds Scheme. The German Government has sanctioned the bill for the obligations which industry has to bear under the Dawes Report for the sum of 5,000 million gold marks (1,190,000,000 dols.). The amounts necessary for the payment of interest and amortisation are to be charged to industrial undertakings in relation to the value of the property above 50,000 gold marks (11,900 dols.).

Four large industries—iron and steel, engineering and electrical, chemical, and textile—have to bear a minimum obligation, which amounts to 20 per cent. of the total industrial obligation for the first, 17 per cent. for the second, 8 per cent. for the chemical, and 7 per cent. for the textile industry.

It would seem from this that in the minds of the Germans themselves there is no doubt that the engineering and electrical industries will play a leading part in the execution of the plan. It may be assumed that in imposing this additional burden upon those industries, they believe that it will not be too heavy a handicap to allow of their competing successfully abroad and so assisting to establish an export surplus. It is not conceivable that they would be able to perform this double task without an enormously increased turnover.

The vast metallurgical machine largely built up since 1919 is to be the principal instrument of the German nation in carrying out their obligations. The German Government, by imposing this burden, makes itself to some extent responsible for the prosperity of German engineering. That this responsibility is fully appreciated may be seen from the fact that it has already passed legislation to reduce the taxation burdens and other costs upon export industries and in particular upon the comprehensive variety of metallurgical industries.

Moreover, the Government's measures for reducing production costs have begun to bear fruit. The 10 per cent. cut of railroad rates and the 10 per cent. cut of coal prices have reduced production costs in the heavy industries by an average of 4 to 5 per cent. The calculated reduction is: Pig-iron, 4·2 per cent.; sheets, 5 per cent.; bars, 3·9 per cent. The reduction of the sales tax from 2½ to 2 per cent. *ad valorem* and the Reichsbank's measures for cheapening credit will also have powerful effects. Essen experts declare that altogether the production cost of heavy steel and iron will fall by 7 or 8 per cent., and of finished metal goods by much more.

An attempt has been made to indicate the extent to which German export activity will have to be increased and the specific commodities on the export of which she is likely to concentrate. It remains to consider in what markets it will be possible to sell these goods. In Table III. an account is given of pre-war German exports by destination.

Table III.—*Destination of German Exports*, 1913.

Country of Destination.	1913 Exports.	
	Millions of Marks.	Per cent. of Total.
Western Europe :—	5,272	52·2
Great Britain	1,438	14·2
France	790	7·8
Netherlands	694	6·9
Scandinavia	675	6·7
Belgium	551	5·5
Switzerland	536	5·3
Italy	393	3·9
All others	195	1·9
Central Eastern and South-Eastern Europe :—	2,405	23·8
Austria-Hungary	1,105	10·9
Russia	880	8·7
Balkan States	214	2·1
Others	206	2·1
North and South America :—	1,547	15·4
United States	713	7·1
Argentine	266	2·6
Brazil	200	2·0
All others	368	3·7
Asia	548	5·4
All others	325	3·2

The markets of Central and South-Eastern Europe are practically non-existent at present. Western Europe, which before the war absorbed 52 per cent. of German exports is under the necessity of economising in every country—the Allies to balance budgets and pay their debts, the neutrals as a result of being involved in the general economic disorganisation. In the Continent of America the United States takes refuge behind a tariff barrier, while the Argentine and Brazil are unable to purchase extensively owing to their reduced sales of raw materials to impoverished Europe. There does not seem any likelihood in the near future that Asia and other undeveloped countries will be able to provide extensive new markets.

The genius of German Industrialists in the matter of commercial policy is notorious, and it will no doubt be afforded scope by the following facts :—By Article 280 of the Treaty of Versailles "one sided most favoured nation treatment" from Germany to the Allies was to cease five years after the rectification of the Treaty unless the Council of the League of Nations gave Germany 12 months notice to the contrary effect. The period for giving notice expired on January 10, 1924, and the obligation will expire on January 10, 1925. The Germans are preparing an active commercial policy to put into operation after that date, and it will no doubt be of some assistance to them in the task of penetrating the markets of the world. But this factor by itself would not count for much in the face of such overwhelming difficulties.

The conclusion is that Germany will have a very hard struggle to sell her goods and that she will only succeed in doing so on a considerable scale by the most ruthless competition, in the lines of goods which she is especially fitted to produce. Foremost in these classes of goods will be the products of her engineering industry. Both in respect of the goods themselves and the contracted markets in which they are to be sold it must be anticipated that Germany will compete principally with this country and that the British engineering industry will, therefore, bear the brunt of the effects of German reparation payments. Finally, however, British

engineering genius and workmanship might be able to meet and overcome such competition in spite of longer hours and lower wages in Germany, the dice will be loaded against them by the fact that the whole resources of the German Government and people will be behind their rivals in ensuring that such competition is effective.

THE PENANG HILLS RAILWAY.

(*Continued from page* 668.)

As already mentioned, owing to the steep slope and the heavy tropical rain which is a feature of the climate, the whole line is constructed in masonry throughout and no loose ballast is employed. The track is built into the masonry and anchored by long bolts at intervals. General views of the track are given in Figs. 38 and 39 above, while details of the construction employed are given in Figs. 40 to 49 on page 727. The rails are of flat-bottomed type with a special head adapted to be engaged by the brakes on the cars. The form is shown in Figs. 48 and 49. The rails are held down by small clips to angle-iron sleepers (having elongated holes) by means of rectangular-headed bolts with square necks which can be inserted after the sleepers are in position. The arrangement will be clear from Figs. 45 to 47, while one of the anchoring bolts to which reference has been made is shown in Fig. 49. The form of fish-plate used is shown in several of the figures; as will be seen, it embraces the whole of the lower portion of the rail and is cut away where it intersects the holding-down clips. It will be clear that the rails can be taken up and renewed without disturbing the sleepers. The tops of the sleepers are laid flush with the masonry as can clearly be seen in the views of the track given in Figs. 38 and 39 on this page, and in Figs. 64 and 65 on page 740. The same construction is employed in cuttings in which a raised masonry bed is provided in the middle with a 3-foot way on each side for storm water and service purposes.

As the railway is single line a passing place for the cars has had to be provided in the middle of each section, and the lay-outs of these are given in Figs. 40 and 42, the former illustrating the upper section and the latter the lower. One of the most interesting features about these passing places is in connection with the arrangements made to ensure that each car shall keep its own track. It is clear that when, say car A, is approaching the passing place shown in Fig. 40, it must always run on to, say, the left-hand side passing track, while when car B is doing the same thing it must pass to the right-hand side. It will be clear that this procedure might be ensured by automatic switches operated by the cars, but actually a method has been applied which has absolutely no moving parts, but which effectively ensures that each car shall take its proper track. The method is ingenious, but very simple. The car A is fitted with double-flanged wheels on the left-hand side and flangeless wheels with very wide tread on the other side, while the car B is fitted in exactly the opposite way—with flanged wheels on the right-hand side and flangeless wheels on the left-hand side. As will be seen from Figs. 41 and 43, the outside rails of each track are continuous while the inner rails are broken to form the crossing. The effect of the arrangement is that the double-flanged wheels of car A follow the outer left-hand rail so that the car keeps to the left, while the corresponding wheels on car B follow the right-hand rail and the car keeps to the right.

A feature which had to be kept in view in the layout of the line was that the haulage rope should always remain in the tread of the carrying pulleys, and that the maximum pitch should be such that under minimum tension the sag in the rope between carrying pulleys should not be so great that there would be any danger of the rope touching the ground. The rope, which was supplied by Messrs. George Cradock and Co., Limited, of Wakefield, has a diameter of 1¼ in. and weighs 11 lb. a yard. The ropes for the upper and lower sections together weigh about 12 tons. Each rope has a breaking strain of 75 tons, and as the maximum load to which they are subjected is about 5 tons, it will be seen that very ample margin for wear is available. It is estimated that the ropes will have a life of about 12 years. They are of the locked coil type, and are made of plough steel.

The types of guide pulleys used on the straight and on curves are illustrated in Figs. 53 and 54, on page 728. These pulleys, as also the rails and sleepers, were supplied by Messrs. L. de Roll, of Berne, Switzerland. The pulleys, as will be seen, are constructed with independent cast-iron treads and bosses, which, in the case of the straight pulleys, are held together by pressed steel flanges. In the case of the pulleys for curves, one of the flanges is formed as part of the boss casting. The pulley journals are carried on brackets, made from flat bar, which are attached to the angle-iron sleepers. Details of the arrangement for straight pulleys are given in Fig. 52, and for inclined pulleys in Figs. 55 and 56. As the tension on the rope increases from the bottom of the line to the top, there is less tendency to sag towards the top of the sections. The guide pulleys are consequently spaced progressively farther apart as the slope increases. The pitch near the bottom of the sections

Fig. 38. View showing Part of Station Platform.

Fig. 39. View of Straight Part of Track showing Arrangement of Sleepers.

THE PENANG HILLS RAILWAY; DETAILS OF TRACK AND PASSING PLACES.

Fig. 40.

Fig. 41.

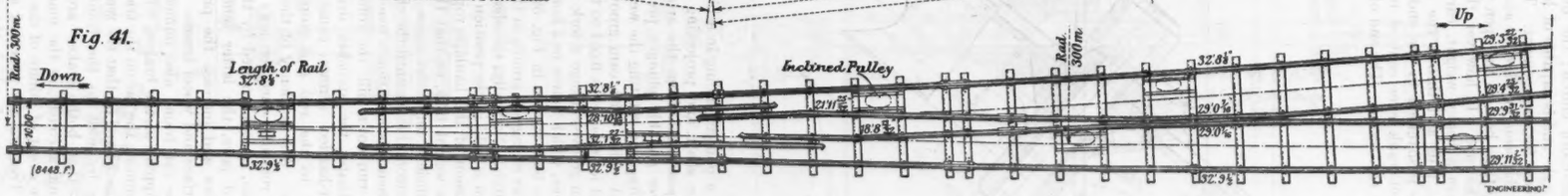


Fig. 42.

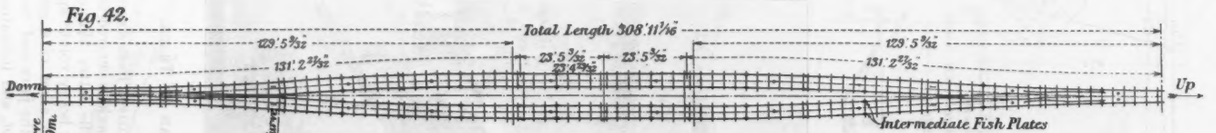
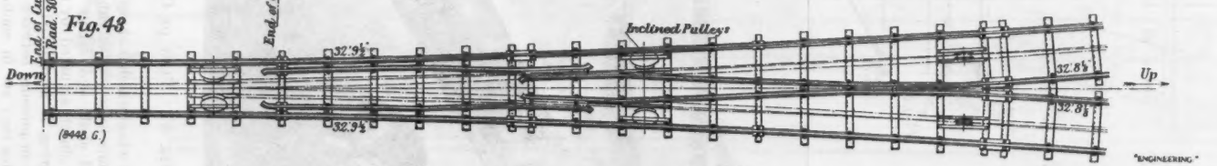


Fig. 43



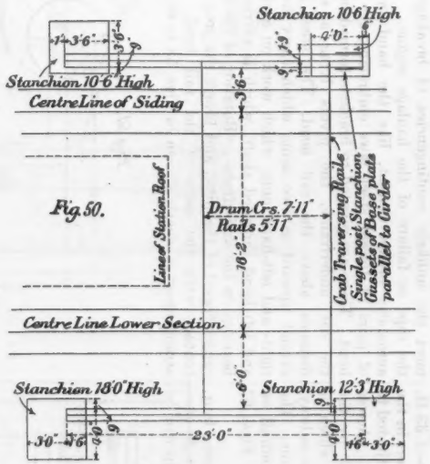
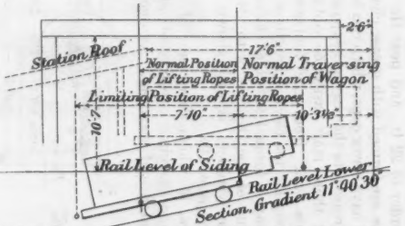


Fig. 51.


Station Roof
Normal Position of Lifting Ropes
Normal Traversing Position of Wagon
Limiting Position of Lifting Ropes
Rail Level of Siding
Rail Level Lower Section, Gradient 11' 40 30
"ENGINEERING."

NOTE.—Squares indicate areas available and positions of (8448 Q.) Base-plates and raking struts of Stanchions

Fig. 45.

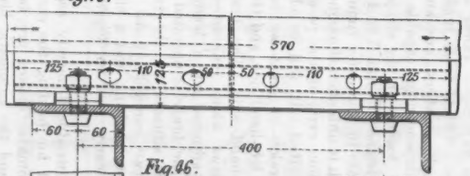


Fig. 46.

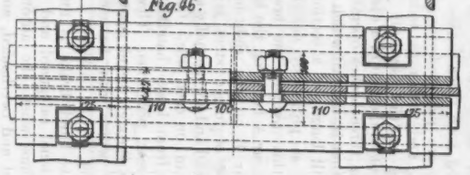


Fig. 44.

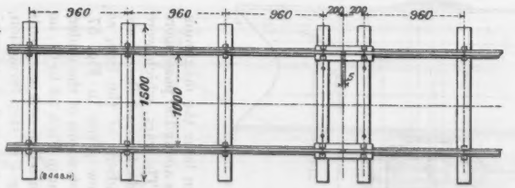


Fig. 47.

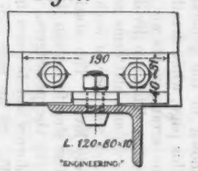


Fig. 48.

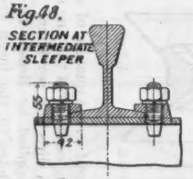
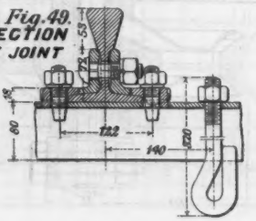


Fig. 49.



is of the order of 22 ft., and near the top of 33 ft. The pulleys are formed with grease chambers in the bosses and have screw caps, which can be adjusted to force the grease into the bearing as required. Access to any of them may easily be obtained by the maintenance staff from the foot-way, which is carried alongside for the full length of the railway. This footway is formed in steps throughout. The arrangement of the footway with its handrail on one of the viaducts is well shown in Figs. 62 and 63, on page 740.

The cars, of which there are, of course, four, each have a carrying capacity of about 40 passengers seated and standing. As one trip can be run about every quarter of an hour the maximum carrying capacity of the line is about 150 passengers in each direction per hour. The cars, which were also supplied by Messrs. L. de Roll, of Berne, are constructed to the mean gradient of the line, as is shown in the general view given in Fig. 57, on this page, while detail illustrations of the underframe arrangements are given in Figs. 58 to 61, on page 729. They are divided into four compartments and two end platforms arranged in step formation, so that the floor of each compartment is approximately level. The station platforms are built in similar step formation to facilitate access to the cars by the passengers. Part of one of the station platforms can be seen in the general view given in Fig. 38 on page 726.

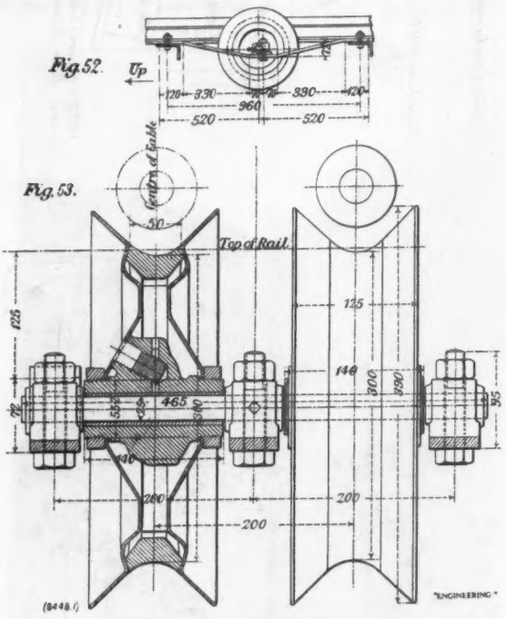
Each car is carried on two rigid axles, and is fitted with three brakes. Two of these brakes, which are patented by the makers, are automatic, and either is independently capable of pulling up the car fully loaded on the steepest gradient of the line in a distance of from 3 to 4 ft. All the three brakes operate on the outer running rail—that is, the rail which is unbroken throughout the full length of a section, even at the passing place, as previously described. It will be clear that this involves the brakes on what we have called car A being on the left-hand side, and those on car B on the right-hand side. The brakes consist of forged steel jaws which embrace the rail head and are normally adjusted with a clearance of $\frac{1}{8}$ in. on each side. One brake is operated by hand from brake handles situated on the front and rear platforms. These connect up to the brake through bevel gears, shafting and a chain drive which can be clearly seen in Figs. 58 and 59.

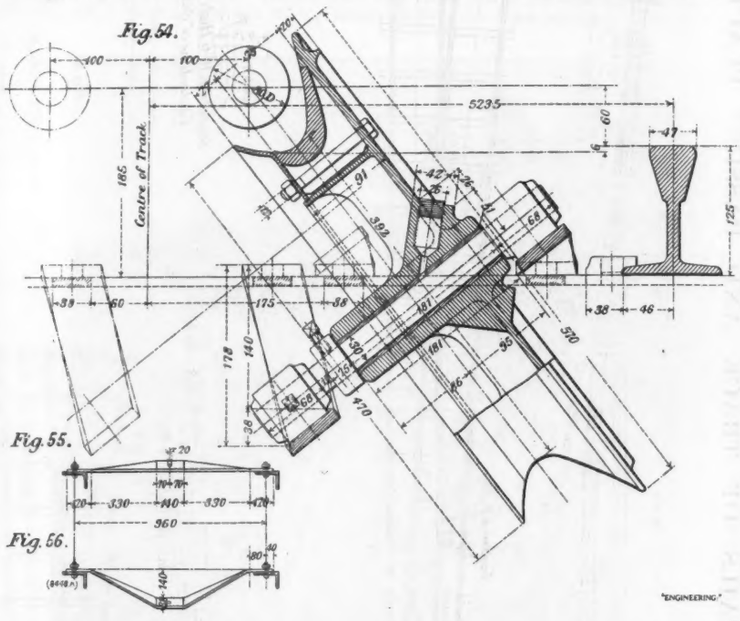
This hand brake is introduced merely as an additional safeguard and for holding the car on the line when the automatic brakes are being tested and overhauled, and the automatic brakes constitute the main safety appliance designed to meet the unlikely contingencies of breakage of the rope or failure of the haulage engine. The automatic brakes consist, like the hand brake, of pairs of forged steel jaws embracing the rail head. These are pivoted to brackets formed below the car underframe, the pivots lying a short distance above the rail head. The steel jaws extend upward in two arms which carry heavy right- and left-hand nuts, which work on a right- and left-hand threaded shaft, which is carried in bearings on the underframe. Rotation of the shaft causes travel of the nuts, and brings the jaws into contact with the sides of the rail head. The arrangement is clearly shown in Figs. 58 to 61. A sprocket wheel which is chain driven from a sprocket which runs loose on the car axle is centred on the threaded shaft and drives the latter through a friction clutch actuated by a heavy volute spring. This spring is introduced to allow of a gradual increase in pressure between the jaws and the rail head after they are in contact, and indicators are provided by the readings of which the initial spring tension can be regulated.

The sprocket on the car axle carries one half of a saw-tooth clutch; the other half rotates with the axle and is capable of longitudinal movement thereon for engagement. The clutch which may best be seen in Figs. 59 and 60, is under normal conditions held in the open position by the tension of the rope. If, however, this tension fails for any reason a heavy weight, carried at the end of an arm, falls and throws the clutch into gear. The rope is shackled to the end of the shorter arm of a bell-crank lever centred in a bracket riveted to the car frame. The end of the longer arm bears on a plunger sliding in a block fixed to the weight arm shaft, and projecting from the block on the opposite side from the arm. The pressure of the lever on this plunger prevents the weight from falling and rotating the weight shaft.

A collar with cam grooves formed in its upper and lower sides is fixed to the weight-shaft. These cam grooves engage a fork carried at the end of a lever, which moves in a horizontal plane and which can be best seen in Fig. 59. The other end of this lever engages a groove in the sliding member of the clutch. Normally, the shaft carrying the weighted arm is held in the position shown in Fig. 59 by the tension of the haulage rope. If this tension fails the weight falls, so that the shaft rotates through sufficient angle to cause the cam to move the horizontal lever until the clutch is thrown into gear. When this condition is reached with the car tending to run down hill, the rotation of the car wheels actuates the sprocket drive and the right- and left-handed screws cause the jaws to clamp on to the rail and stop the movement of the car. Any tendency of the wheels to slide, instead of rotating, once the jaws are in contact with the rails, is counteracted by the form of the rail head and jaws, the latter tending to slide down the faces and increase the pressure between the rail surface and wheel treads. A slight deformation of the car frame also immediately results from the gripping of the brakes, which materially assists in jamming the car on the track. It will be seen from Figs. 58 and 59 that the rear brake gear is connected up by rods to the front automatic brake gear, so that both brakes are thrown on practically simultaneously, in the manner described above, in the event of failure of the rope tension.

Treadles are provided at either end of the car by means of which the attendant can withdraw the plunger in the block on the weight-arm shaft, thereby permitting the weight to fall although the full tension is on the rope. This releasing gear is introduced to enable the attendant to stop the





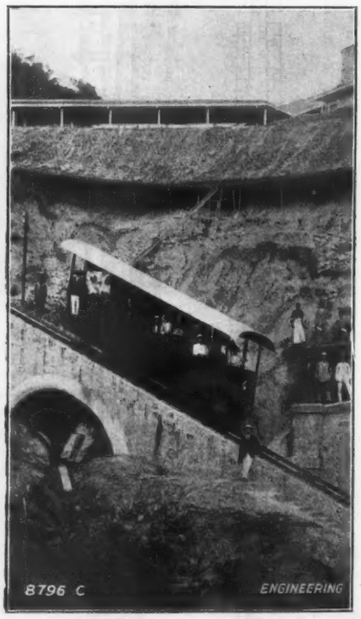
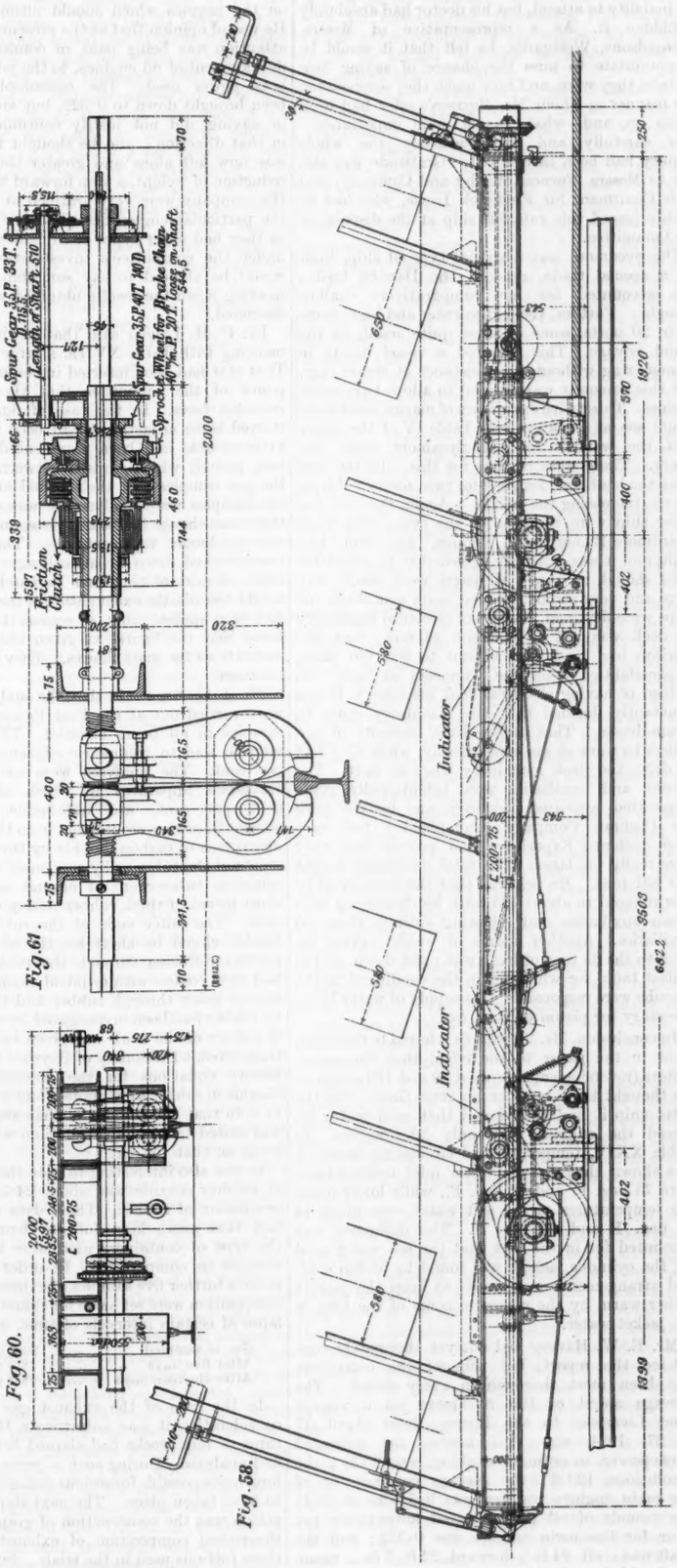
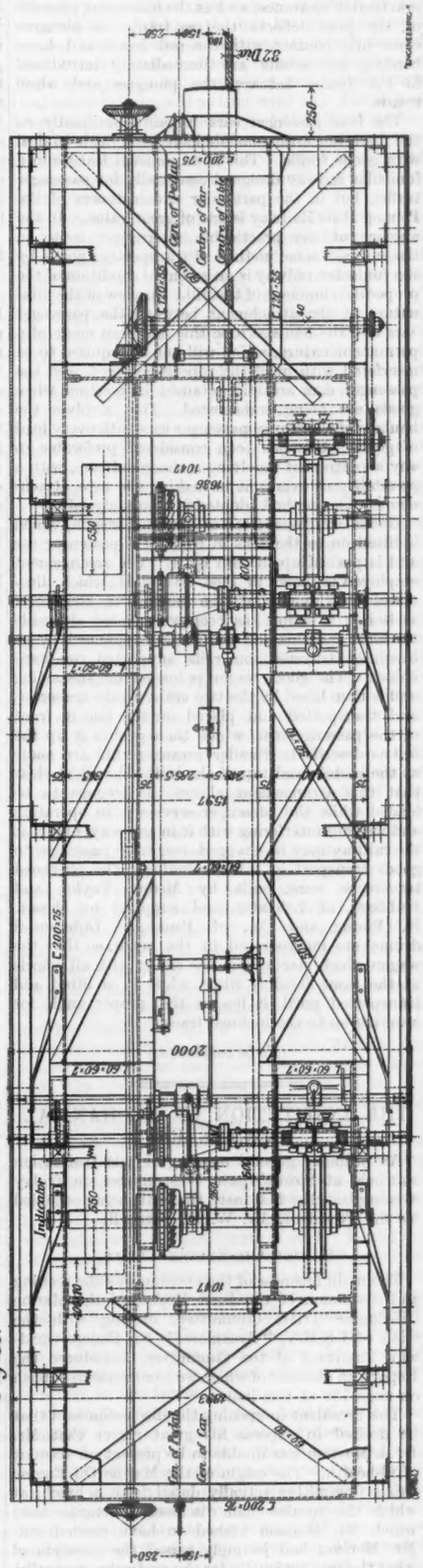


FIG. 57. VIEW OF CAR ON TRACK.

PASSENGER CARS FOR THE PENANG HILLS RAILWAY.

CONSTRUCTED BY MESSRS. L. DE ROLL, ENGINEERS, BERNE, SWITZERLAND.





car in case of sudden emergency. On the opposite side of the brake jaws from the wheels, a vertical plunger is fitted acting directly on the rail head and capable of adjustment for clearance by means of an eccentric. It is maintained with the minimum practicable clearance, and as the increasing pressure of the jaws deflects the car frame the plungers come into contact with the rail head, and large bending movements are immediately introduced in the frame between the plungers and wheel treads.

The four passenger cars remain continually on the road, but arrangements have been made to deal with goods traffic. This is an unusual feature in a funicular railway designed essentially for passenger traffic, but in the particular circumstances of the Penang Hills Railway is one of great value. In the absence of any practicable alternative route to the summit, some method of transporting goods by the funicular railway is an essential condition of the proper development of the hill. In view of the vital nature of the attachment between the passenger cars and the haulage rope this has been made of a permanent nature, which will not be required to be interfered with until the rope is renewed, and the passenger cars are still retained in position when goods are being transported. This involves the haulage of the empty passenger cars with every load of goods; this has been considered preferable to any arrangement involving a change of cars, with a possibility of oversight in making the rope attachment. The method adopted is absolutely safe.

Goods are transported in a special wagon, which is lifted on to the rails in front of a passenger car and is pushed up the hill by it. The arrangement employed is shown in Figs. 50 and 51, which illustrates the lay-out at the bottom of the lower section. A siding has been constructed alongside the line, and this and the line are spanned by an overhead traverser on rails supported on stanchions. The goods wagon is loaded on the siding and is then lifted by the two crabs on the traverser, and transported and placed on the line in front of the passenger car, which then pushes it up the hill as described. Similar arrangements are made at the middle and top of the hill. It will be clear that this arrangement allows the wagons to be loaded while the passenger service is in operation and without interfering with it in any way, and that the railway may be changed over from passenger to goods transport in a few minutes. The overhead traversers were built by Messrs. Taylor and Hubbard, of Leicester, and supplied by Messrs. R. Young and Co., of Penang. Differential drums are incorporated in the crabs, so that the wagon which starts from the siding with all wheels at the same level is tilted while it is lifted and transported until it lies at the proper angle for lowering on to the inclined track.

(To be continued.)

THE INSTITUTION OF MECHANICAL ENGINEERS.

An ordinary general meeting of this Institution was held at Storey's gate, Westminster, on Friday evening last, the 21st inst., the chair being occupied by the President, Mr. W. H. Patchell.

Marine Oil-Engine Trials.

The main business of the evening was the reading and discussion of the First Report of the Marine Oil-Engine Trials Committee, dealing with the trials of T.S.M.V. "Sycamore." Sir George Goodwin, Chairman of the Committee, introduced the Report, an abstract of which we commence to publish on page 750 of this issue.

The President in opening the discussion said that he desired to express his great regret that Mr. D. B. Morison was unable to be present on account of ill-health. The origin of the Marine Oil Engine Trials Committee actually dated from a lunch, at which the speaker had discussed oil-engine tests which Mr. Morison wished to have carried out. Mr. Morison had jestingly raised the question of what the Institution did for the profession generally, whereupon he had reminded him of the steam engine trials conducted by the Institution 25 years ago. The outcome of that talk was the offer referred to in the report.

Mr. Tom Westgarth said that Mr. Morison had charged him particularly to explain his regret at his inability to attend, but his doctor had absolutely forbidden it. As a representative of Messrs. Richardsons, Westgarth, he felt that it would be inappropriate to miss the chance of saying how grateful they were, and how much they appreciated the manner in which Mr. Morison's offer had been taken up, and—what was of more importance—how carefully and conscientiously the whole enquiry had been carried out. Gratitude was also due to Messrs. Furness, Withy and Company, and their Chairman, Sir Frederick Lewis, who had so readily placed this valuable ship at the disposal of the Committee.

The Sycamore was a special type of ship, built for a special trade, namely, the Danube trade; this accounted for her comparatively shallow draught. Further, she had to enter and leave some 15 to 20 ports, some of these quite small, on the round voyage. This required a vessel handy in manœuvring without the assistance of steam tugs. For this reason it was decided to adopt twin-screw engines. Those with experience of marine machinery would see at a glance from Table IV of the paper that the weights for the Sycamore were very heavy. There were reasons for this. In the first place the boat was designed for twin screws; this, of course, increasing the weight. Again, this and her sister ship were the first of the type, with Tosi-Beardmore-Richardsons engines, his firm had built, and it was generally agreed that no avoidable risks should be run. All parts were made very large and very strong. Three years ago, when the ships were designed, the use of electrical machinery on deck was not so common as now, and Mr. Morison had been anxious not to put too many responsibilities upon the engineers at once. So instead of having electrical deck machinery, it was reluctantly decided that the machinery must be steam-driven. That involved the necessity of two boilers to work at sea continuously, while they had to drive the deck machinery when in port. The pumps and auxiliaries were intentionally made larger than appeared necessary, and for the work the Cochran Company recommended two very large boilers. Experience had proved that they were really too large. The total machinery weight was 891 tons. He believed that this total could be now reduced to about 725 tons, by dispensing with steam auxiliaries and adopting entirely electrical auxiliaries. Another source of weight saving related to the 35 tons of fresh water put down in the ballast tank, for which again the conditions in the Danube were responsible, this supply of water being necessary for piston cooling, &c.

In conclusion, Mr. Westgarth referred to the statement in the paper to the effect that the servo-motors (reversing engines) used 80 and 100 amperes. He thought there must be an error there. On the sister ship it had been found that each motor reversed the engines with only 30 amperes. In Table XXIV, temperature of circulating water, it was shown that the sea water inlet temperatures were 75 deg. F. and 62 deg. F., while lower down the temperatures of the salt water were given as 46 deg. F and 50 deg. F. The difference was accounted for in the fact that the sea water used for the cylinder jackets was found to be too cold, and arrangements were made to keep the jackets rather warm by the return of some of the heat of the jacket water.

Mr. E. W. Harvey had not yet thoroughly considered the report, but thought the committee had been most thorough in every detail. The average speed of the Sycamore on a voyage from Liverpool to the Piræus, from April 17 to 27, 1924, was 11·7 knots; the indicated horse-power, in ordinary working, was 2,738; the revolutions, 120·8; the average consumption of the main engines per day was 9·5 tons of fuel; the pounds of oil per indicated horse-power per hour for the main engines was 0·322; and the draft was: aft, 24 ft.; forward, 22 ft. 3 in.; mean, 23 ft. 1½ in. At the present moment about 32 different kinds of Diesel engines were on the market. The burden placed on a superintendent in choosing an engine for marine propulsion was therefore very great. Consequently, the superintendents looked to such a committee as the Marine Oil-Engine Trials Committee to assist them in forming their opinions on the engines which should ultimately be used. He was of opinion that at the present time too much attention was being paid, in connection with the development of oil engines, to the pounds of oil per horse-power used. The consumption had now been brought down to 0·322, but small differences in saving did not justify continual experiments in that direction; and he thought that if the fuel was now left alone and greater thought given to reduction of weight, a step forward would be taken. His company were very gratified at the running of the particular engine described in the report, and as they had other types of engines which had been under the committee's investigation, perhaps he would be allowed to say something at a further meeting when the results obtained with these were discussed.

Dr. C. H. Lander said that in the report, commencing with Table XVIIb, a large star appeared. That star had been inserted in conformity with the policy of the committee that they must report recorded facts. In the case of figures that were starred some adjustment had been introduced. A little trouble had been experienced owing to the long periods which elapsed between the taking of the gas samples and their actual analysis. When the samples were analysed it was quite apparent that some change had taken place, and that a sample was no longer representative. That change had been tracked down by his colleague Mr. King, the chief chemist of the Fuel Research Station, who would describe the exact nature of the correction that had been applied; but, of course, it must be recognised that the figures as given there were not as accurate as the main figures. They were not direct readings.

Mr. J. G. King said that the analyses referred to were carried out at the Fuel Research Station, 21 samples in all being received. They were found later to lead to volumetric efficiencies of over 100 per cent. The analyses were carried out in a Haldane's apparatus in which an accuracy of 0·02 per cent. was obtainable. The possible sources of error were leakage from the containers or absorption of carbon dioxide by the rubber attachments of the tubes or by condensed moisture. The sampling tubes were of normal shape, but with short pieces of thick rubber tubing closed by screw clips. The outer ends of the rubber tubes were further closed by short lengths of glass rod. To prevent diffusion through the rubber the outside had been coated with celluloid varnish. The diffusion of gases through rubber and their absorption by rubber had been investigated by several workers. A history of the work was given by Dr. J. Barr in Glazebrook's Dictionary of Physics, vol. v. In that history equations for the absorption of carbon dioxide in rubber were quoted, and it was interesting to note that the amount of that absorption, which was stated to be simple solution, was ten times as great as that for air.

It was also interesting to note that the solubility of sulphur dioxide was about 24·5 c.c. per cubic centimetre of rubber. Those data emphasised the fact that gases kept for any length of time in the type of containers used were liable to serious changes in composition. In order to prove that point a further five samples of exhaust gas of known composition were set aside for examination after the lapse of certain intervals of time, and showed

Gas as sampled	20·3 per cent. CO_2
After five days	18·8 per cent. CO_2
After thirteen days ...	18·2 per cent. CO_2

In the case of the exhaust gas samples under consideration it was unfortunate that a period of three or four weeks had elapsed between sampling and analysis. During such a period it was, therefore, quite possible for serious changes in composition to have taken place. The next step in the investigation was the construction of graphs showing the theoretical composition of exhaust gas from the three fuel-oils used in the trials. Such a graph was easy to construct by calculation from the elementary composition of the fuel used.

The percentage of oxygen in air had been taken

at 20·9. At infinite dilution the nitrogen in the exhaust gas would be 79·1 per cent., while, at the other end of the scale, where the theoretical minimum of air was used the points were, for example, in one case, 84·30 per cent. nitrogen and 15·70 per cent. carbon dioxide. When the 21 analyses were tried on the graphs every one of them was found to be apparently too low in carbon dioxide. The explanation of the high volumetric efficiencies was therefore apparent. Further calculations were then carried out in order to arrive at some idea of the composition of the gases as sampled. Such a proceeding was by no means a desirable one, and the only satisfactory way out of the difficulty was really to repeat the trials. That procedure being impossible, it was finally agreed to make the necessary calculations assuming that the only change which had taken place was loss of carbon dioxide, by solution in the rubber caps or in the small amounts of condensed water found in the tubes. The mechanism of the correction might be explained by taking an example from Test 15.

The analysis of one sample on July 11 gave :—

	Per Cent.	Volumes.	
CO_2 ...	3·42	3·42	
CO ...	0·12	0·12	
O_2 ...	11·70	N_2 40·56	corresponding to 10·73 O_2
N_2 ...	84·76	O_2 11·70 N_2 44·20	excess air
	100·00		

That composition was out of agreement with the graph. In column 2 the composition was shown as flue gas and excess air. The nitrogen in the flue gas (40·56 vols.) corresponded to 10·73 volumes of oxygen which had been consumed. For that fuel oil the ratio of oxygen required for the formation of carbon dioxide to that required for the formation of steam was 0·694 : 0·306. The carbon dioxide which should have been produced from 10·73 volumes of oxygen should have been :—

$$0{\cdot}694 \times 10{\cdot}73 - 0{\cdot}06 = 7{\cdot}39 \text{ volumes.}$$

The loss of carbon dioxide in that flue gas was, therefore :—

$$7{\cdot}39 - 3{\cdot}42 \text{ or } 3{\cdot}97 \text{ volumes.}$$

The corrected analysis corresponding to that 103·97 volumes was as follows :—

	Volumes.	Per Cent.
CO_2	7·39	7·11
CO	0·12	0·12
O_2	11·70	11·25
N_2	84·76	81·52
	103·97	100·00

Corrected analyses obtained in that way had been used in the calculation of certain results marked with a star, but it must be emphasised that those results were not based on direct observation, and such a procedure was to be strongly deprecated.

Mr. E. B. Moullin said it was perhaps, somewhat surprising that the discrepancy between value of the torque as measured from the two torsionmeters and the predicted value of the torques in the case of the shore trials was so appreciable ; he referred to the lines (*c*) and (*e*) of Table XXX in the report. The measured torque was some 20 per cent. to 30 per cent. less than the predicted torque. An enormous amount of power appeared to be absorbed between the flywheel and the propeller, attributable, presumably, to the thrust blocks and journal. In the port shaft, 10 per cent. of the I.H.P. seemed to disappear between the fly-wheel and the propeller and about 17 per cent. in the case of the starboard shaft (Trial I.) and more still in the low-power second trial. The combined overall mechanical efficiency of the two engines in the full-power trial seemed to be only of the order of 61 per cent. If in the future the report could be further amplified, it would be of great interest if something could be told about the extent of the variation from the mean values observed. In measuring the torque on the port shaft during the four-hour full-power run, the torque was reduced by 11 per cent. between the beginning and the end of the trial, and he would much like to know whether there was a corresponding decrease in the I.H.P. or whether the change of 11 per cent. in torque was entirely due to a change in the mechanical condition of engines, thrust blocks, &c. With regard to the time over which the difference was spread, he thought the value of 36,000 lb.-ft. was more probable for the mean value of the period than the 37,640 lb.-ft., arrived at as the arithmetical mean of the values.

Mr. Moullin then proceeded to exhibit slides bearing on his remarks. These were records made with his torsionmeter, illustrating the change in torque which occurred in the engine, by means of which he argued that the arithmetic mean did not give satisfactory values.

One of these represented a record taken at the beginning of the full power trial, and showed certain irregularities in the torque record. In every record some of these irregularities could be traced to cylinders 2 and 5. It was interesting to note that in Table XXV of the report the mean values of M.I.P. for cylinders 2 and 5 were higher than any other. These two cylinders were responsible for increasing the mean M.I.P. by 1·1 lb. per square inch above the mean of the other four. The irregularities observed were of two kinds—deficits in torque and increments in torque. He would refer to the deficits as "misfires," and to the humps or increments as "detonations" for want of more suitable words. In considering one misfire, indicated, it would be noted that the torque rose immediately afterwards to about the same value that it would have been if the misfire had not existed. Apparently the misfires should be attributed less to complete misfiring than to very late firing, having the advantage of a high crank angle to make up for the deficit on the early pressure.

In some cases shown the instantaneous value of the torque after detonation rose to about 50 per cent. above the normal value if no detonation had occurred, and the torque was maintained at a value above normal for about 36 deg. of crank angle. It was perhaps reassuring that the maximum stress did not amount to more than 50 per cent. above normal full load running, and it was also rather remarkable that so sudden a change of stress should reach right through past the flywheel. He had been at some pains to discover whether the misfires followed a detonation or *vice versa*. After examining about 30 instances, he had found only four in which the misfire followed a detonation. During the slow-speed trials the irregularities were absent, only one instance occurring.

The next slide represented a record of stress alternations in an ordinary spring, showing the dying sine curves. It was of interest as showing the *bonâ fides* of the records. The last slide shown was almost a precise image of the previous one, but was a record, taken on the Sycamore, of the shaft stresses. It showed the engine running down from ahead to stop, and illustrated the phase during which the revolutions passed through the natural period of the shaft. It was indicated how markedly the torque pulsations during three explosions of three cylinders had been built up, due to coincidence with the natural period of the propeller and shaft.

Mr. Tom Westgarth said he understood from the last speaker that there was a large loss shown in some cases and not in others. That needed explanation. Engines did not fail in that way. During the whole trials the engines were running steady, with no hot bearings or hot thrust to account for the trouble.

Mr. J. H. Narbeth said there could be no doubt as to the reliability of the records in the report. The makers were to be congratulated on the engines they had supplied, because nothing had been heard about any springs or valves breaking or sticking or any parts of the machinery getting coked up. The *bonâ fide* character of the results would inspire, he hoped, confidence in those who desired to make inquiries, while they should show designers where they could make still further improvements. Further, very great value would be obtained from the trials, because engineers would know what to expect when such ships were in service. It would be seen that at sea, with a horse-power of 3,000, the fuel result was obtained of 0·34 lb. per indicated horse-power per hour, and 0·34 lb. ashore ; while at 2,000 h.p. the figure was 0·32 lb. afloat and also 0·32 lb. ashore. The agreement obtained therefore was very close, and it had been stated that the figures obtained from the sister ship were about the same. As a great believer in Diesel engines, he thought it was necessary to impress upon owners and shipbuilders the wonderful way in which the Diesel engine would maintain a low consumption at sea as well as on shore, and not only so, but for several years afterwards the consumption would not get worse, but might actually improve. The Diesel Engine Users' Association, of which he was a member, had during the last few years collected an immense amount of information, which showed that Diesel engines had been running in some cases for a very great number of years, and the condition had actually improved as time went on. Doubt was expressed as to the efficiency of the Diesel engine, but he was perfectly certain in his own mind that a Diesel engine ought to be supplied in place of steam engines for all powers up to about 3,000 h.p. at any rate.

He thought it would have been well worth while if a little further cost had been incurred in connection with two matters. First of all the trials should have been run with varying draughts, and in case of further trials he hoped the foul bottom of the ship would not be allowed to introduce serious difficulty in making any exact comparisons. It would be well worth while giving the ship a start on its sea trials with a clean bottom in order that the comparisons might be of some real value. He had been very much struck with the simplicity and the beauty of the director valve, and he also liked the independent fuel pump. The easy and quick control through all the powers and the running at very low revolutions was a strong recommendation of the engine. As regards the future, although the efficiency that had been obtained was very high, a brake thermal efficiency of 31·3 per cent. being recorded, there was plenty of room for progress, because the temperature of the exhaust was still from 600 deg. to 700 deg., and at the same time the oxygen carried away in the exhaust appeared to amount to about 25 per cent. of the oxygen of the air supply. If the whole of the oxygen could be consumed it would be possible to get 33 per cent. more power out of each cylinder. He did not like the use of so much compressed air, and he would be very glad if some improvement in that direction could be obtained. With regard to the general use of electricity for auxiliary machinery and for ship use, it must be remembered that there was a wonderful convenience in steam. Low-temperature steam was of very great service in ships. Electrical engineers should help them by supplying some means of obtaining low temperatures of 100 deg. to 250 deg. by some economical electrical appliance.

Engineer-Commander H. B. Tostevin, D.S.O., said he only wished to refer to certain modifications that were made in the taking of the indicator diagrams, particularly the light spring connections, and also a modified indicator rig. With the modified indicator rig, on one cylinder the mean pressure was 101 lb. per square inch, and for the same cylinder the mean effective pressure taken with the ordinary reducing gear was 93 lb. per square inch. The statement was also made that the divergence in that case might be assigned to the effect of the stretch of the cord, assuming the conditions of running to be identical. Granting that it was due to the stretch of the cord, it seemed to him that as the first method had the longest cord it reflected on the accuracy of the diagrams which were taken with the long length of cord. He did not understand why such a tremendous difference arose, and he would be very grateful to any of those who had taken the tests if they could explain that point, because assuming other measurements depended on the indicated horse-power, in drawing up the heat balance data unless the indicated horse-power was exact it must affect so many other readings in the tables.

Mr. B. P. Fielden said that from the sea-going point of view, the report that had been produced would be very valuable. The report indicated how the efficiencies and the loss of heat altered as the load on the engine was altered. Those facts in themselves would make chief engineers think and that would result in good being done and greater efficiencies being obtained. He appealed to the shipowners to come forward and help the committee more, so that the work which was

HAULAGE EQUIPMENT FOR MINES.

CONSTRUCTED BY MESSRS. HOLMAN BROS., LIMITED, ENGINEERS, CAMBORNE, CORNWALL.

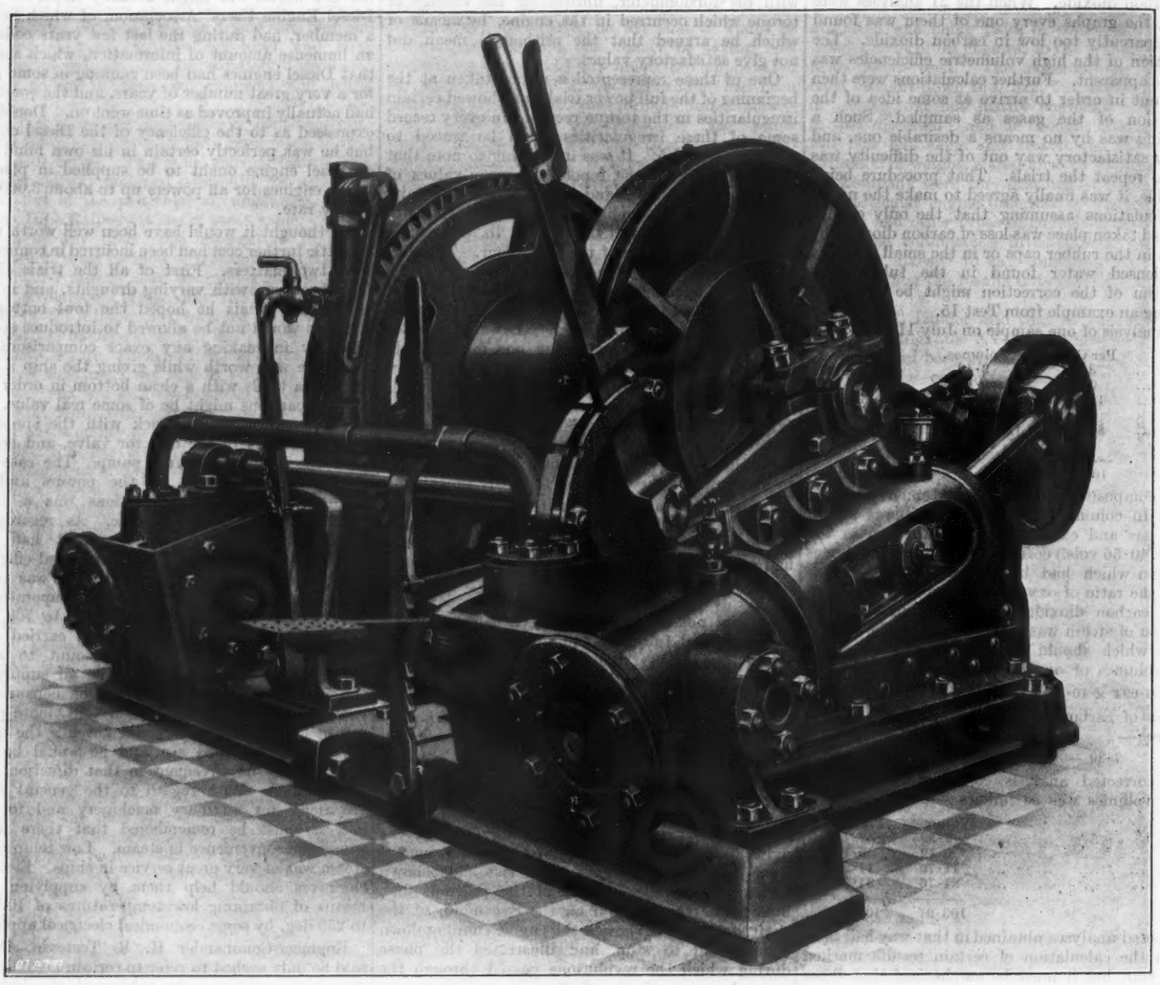


FIG. 1. 20-H.P. HAULING OR WINDING ENGINE WORKING WITH COMPRESSED AIR OR STEAM.

being carried out could be accomplished more quickly, with the result that further reports would be published more promptly.

The President said he desired to say a word with regard to finance. The Institution was very much indebted to Messrs. Richardsons, Westgarth and Co., and Messrs. Furness, Withy & Co., for the loan of the engines and the ship, and they were further indebted to them for their gift of 1,000*l.* to enable the trials to be instituted. Without that money it would not have been possible to do the work at all. Nothing in the nature of a public appeal had been made. Nevertheless, sums had been given towards the work by Messrs. Alfred Holt, who also lent a ship for trial; the Lancashire Shipping Company; Mr. Williamson; Messrs. Anderson, Green and Co.; the British-India Steam Navigation Company; and the Ellerman Line. The Council had had before it a report from the Oil Engine Trials Committee, which stated that the shore trials of the "Palmer-Fullagar" engines had been carried out at Jarrow; also that the sea tests of the M.V. Sycamore, Pacific Trader and British Aviator had been completed. There still remained to be carried out the tests at sea of the ship propelled by the Werkspoor engines. Money was holding up the publication of the results. He hoped that the valuable report which had been presented that evening would spur other members to make further contributions in order that the other reports might be published.

Sir George Goodwin then replied briefly to some of the points raised in the discussion. The report was valuable in itself, but its full value would not be appreciated until the other reports were available. Mr. Westgarth had referred to the current supplied to the servo-motors, believing some error to exist. Of course, the Committee desired the figures to be accurate, and he could only remark that the figures given were those taken at the trials. If these figures were inaccurate, then the instruments placed at the disposal of the Committee were not accurate. Dependence had to be placed upon something; the Committee was not rich enough to test everything, but they took the instruments given and made records with them. Referring to Mr. King's interesting observations about gas exhaust analyses, he would say that since the Committee was formed those figures had been a matter of some concern to its members. He felt that most engineers would be satisfied that the figures should be taken as authentic as they appeared, but the Committee had not felt justified in concluding that, and an asterisk had been placed against figures which had involved the use of corrected analyses.

To those who were prepared to accept the explanation given by Dr. Lander and Mr. King, the figures, he was sure, would be very useful. The Committee considered that the results given by the Moullin instrument were sufficient to deserve confidence. Commander Tostevin had questioned certain figures. He hoped it would be possible to find an explanation of the point raised.

The President then put to the meeting a vote of thanks to Sir George Goodwin, which was carried unanimously. He announced that the Report would be further discussed in Glasgow and Manchester on December 4 next, and in Liverpool on December 5. Further, that in connection with the informal meeting to-night the Library would be kept open until 7 o'clock. There would be an extra general meeting on Friday, December 5, when papers on "The Effect of Low and High Temperatures on Materials," by Prof. F. C. Lea, and on "The Elastic Limit in Tension and its Influence on the Breakdown by Fatigue," by J. M. Lessells, would be read and discussed.

The Annual Dinner of the Institution would take place on December 18, and H.R.H. The Prince of Wales had kindly promised to attend. The proceedings then terminated.

HAULAGE EQUIPMENT FOR MINES.

MINE haulage plant, no matter what specific duty it is designed for, must possess the essential characteristic of substantial construction, to withstand the stresses due to the heavy duty put upon it, and

HAULAGE EQUIPMENT FOR MINES.

CONSTRUCTED BY MESSRS. HOLMAN BROS., LIMITED, ENGINEERS, CAMBORNE, CORNWALL.

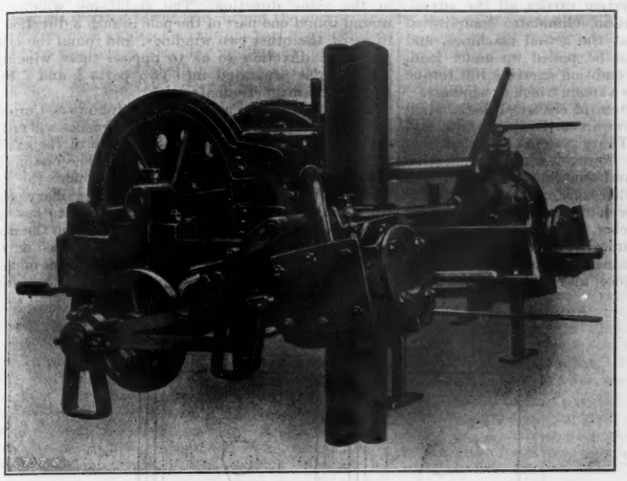


FIG. 2. STRETCHER BAR HAULAGE.

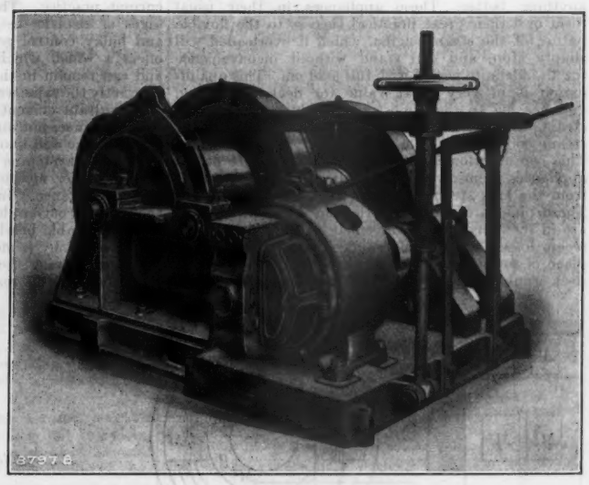


FIG. 3. 15/20 H.P. ELECTRIC HAULAGE OR HOIST.

the harsh treatment to which it is commonly subjected. In addition, it must be of design suitable for control by attendants, who may have but little training or experience in handling machinery. The conditions of use are, therefore, of as severe a nature as is to be found with the use of machines in any type of industrial work. To show the way in which the designers of such plant have met the exacting conditions, we illustrate above and on the opposite page three examples, all constructed by Messrs. Holman Bros., Limited, of Camborne, Cornwall.

The example, which is illustrated in Fig. 1, is a hauling or winding engine suitable for operation by compressed air. It consists essentially of two air motors or engines, with reversing gear, mounted at the ends of a bedplate, over the centre of which the large winding drum is situated. Both engines drive the same crankshaft, on which a pinion is fitted, which gears with a spur wheel securely keyed to the drum. Valves for the control of the air are provided, and there is a brake on the winding drum to ensure that it may be slowed down or stopped at any desired moment. The substantial characteristics of the components of the equipment may be gauged from the illustration, Fig. 1, and when the details are considered it will be seen that the designer has made every endeavour to obtain reliable and economic working, combined with the elimination of anything causing heavy wear and tear.

Upon the heavy cast iron bedplate, which is made in halves and bolted together, there are erected two cast steel side frames, which are machined to accommodate the guides and to give support to the bearings. The centre lines of the engines are set at an angle of 15 deg. to the horizontal. The cylinders, as will be seen from the illustration, are very simple castings. They are of 6-in. diameter and 8-in. stroke and are provided with feet with machined undersurfaces for accommodation on the bedplate, while the inlet and exhaust flanges are machined faced and provided with studs to secure the respective pipe flanges in place. Pistons of cast iron, with spring rings of the Ramsbottom type, are used. The rods are of mild steel, fitted into the pistons and secured by nuts, while the other ends are screwed into the crossheads and secured by lock nuts. The guides are bolted to the cast steel side plates and are bored and scraped to accommodate the crossheads, which are of cast steel, and finished by machining and grinding to fit the guides.

The valves are of the simple D-type, sliding on a machined and scraped valve face, and are secured to the spindles by lock nuts. They receive their motion through a reversing link motion, of which the eccentrics are of cast-iron, and securely keyed to the crankshaft. The straps are in halves and held together by turned steel bolts. The reversing shaft is keyseated for the accommodation of the various levers, and is supported at one end by a cast-iron bearing and at the other in a cast-iron quadrant. For effecting the changes in linking up and reversing, a substantial hand lever is provided, which is fitted with a locking device. For building up the crankshaft the discs are forced on the shaft and keyed in position and the crank-pins, which are made of mild steel, are fitted into taper holes in the discs and then riveted over. The drum barrel is a plain hollow cylindrical casting, 15 in. diameter, which is turned to receive the brake wheel at the one end and the spur wheel for the drive on the other, these parts constituting the drum sides. Upon the brake wheel there is a mild steel encircling band lined with wood blocks, a foot lever system being provided to put it into action, while effective locking and releasing arrangements are part of the equipment. Lubricators are provided for the cylinders, guides, bearings, connecting rods and eccentrics, and drilled oil holes allow the passage of the lubricant to all other working parts of the plant. The whole of the control system, including throttle valves and reversing lever, are arranged close to one another to facilitate the control. This plant may be operated by steam as well as compressed air, and the approximate consumptions amount to 330 cub. ft. of free air per minute or 700 lb. of steam per hour when the admission pressure is, in either case, 80 lb. per square inch. The machine will lift vertically a gross load of 2,600 lb. or pull up a load on a 30-degree gradient of 4,900 lb.

Nearly a quarter of a century ago Messrs. Holman Bros., Limited, introduced into mine working the first portable haulage engine, mounted on a stretcher bar. The system proved very acceptable to the mining engineers of this and other countries and now-a-days finds extensive use. Once the location where the haulage plant is required is settled, the bar is readily accommodated in place, as it is provided with a double jack support at the foot for the purpose. Wooden battens are introduced above and below to ensure that a good bearing surface is obtained. To this stretcher bar the haulage equipment is clamped by means of bolted rings. As the removal and reinstatement of a few bolts on the clamps ring is all that is necessary, either to adjust the position of the plant on the stretcher bar or to fix it in position originally, it will be recognised that setting up requires the expenditure of very little time. The haulage gear is driven by two engines, which are operated on compressed air or steam, the dimensions of the cylinders being 4¼ in. bore and 6 in. stroke. The air consumption amounts to about 187 cub. ft. of free air per minute, or alternatively, the cylinders may be supplied with steam when the consumption would be approximately 385 lb. per hour when working with a supply pressure of 80 lb. per square inch. The diameter of the drum is 9½ in., and the rope from it may be used in lifting a gross load of 3,600 lb. vertically, or can pull a load of 6,800 lb. up a 30-degree gradient.

Messrs. Holman Bros., Limited, also make electrically operated haulage gear, a good example of their work being shown by the 15/20-h.p. single-drum electric hoist, illustrated in Fig. 3. The qualities of compactness and strength already observed in the engine-driven sets are also evident here. The leading features in this design are its self-contained arrangement, the inclusion of a caliper type brake, a clutch pinion and guarded gears.

The entire equipment is mounted on a heavy bedplate of box section, on which machined surfaces are provided to receive the side frames, bearings and the motor. From the motor a drive is obtained through a flexible coupling to the first motion shaft. This has machine-cut teeth, the pinion being of mild steel, while the wheel is cast-iron. The second motion gears have moulded teeth. The cast-steel clutch pinion has a square hole which fits the intermediate shaft, and is put into and out of action by the use of pins on the curved arms at the end of the operating lever, which work in a groove on the sleeve end of the pinion. For the hand lever with which the clutch pinion is put into engagement, a rest plate is provided to which the lever may be held in any position by the use of a pin. The drum is 1 ft. 6 in. in diameter, and can raise a hanging load of 1,400 lb., or can pull a weight of 2,500 lb. up a 30 deg. gradient. On the one end of the drum the spur wheel forms one side while the other is provided by a machined brake wheel. On this a caliper type of brake, which is hand operated, is accommodated. This brake has cast-steel posts fitted with wooden blocks. In addition to the hand lever a screw and hand wheel are provided, so that any desired pressure may be applied and maintained.

THE ÖRSTED MEDAL.—The H. C. Örsted medal was presented to the Danish scientist, Professor Niels Bohr, on the occasion of the hundredth anniversary of the formation by Örsted, of the Society for Propagation of Natural Science. Professor Martin Knudsen, in presenting the medal to Professor Bohr, read an address signed by the most famous Danish scientists in the field of natural science. Professor Knudsen referred to Tycho Brahe, Ole Römer and H. C. Örsted as names of which Denmark was proud, each, in a way, representing a century, and to this honourable list the name of Niels Bohr could now be added for the twentieth century. Professor Bohr, in responding, spoke about the development of our conception of the atoms. In spite of great difficulties, it had been possible to build up a theory, so that one was now able dimly to see a standpoint, viewed from which the existence and characteristic qualities were to be considered not as the outcome of Nature's inscrutable caprices, but as an expression of the same general laws, into which the study of physical phenomena had given us an insight.

MESSRS. BABCOCK AND WILCOX, LIMITED, AND PULVERISED COAL.—As the result of an investigation carried out by Messrs. Babcock and Wilcox, Limited, of London, in conjunction with the Babcock and Wilcox Company of New York, on various systems of using pulverised fuel, the British company has entered into an agreement with the Fuller-Lehigh Company of America to operate under their patents. Under this agreement Messrs. Babcock and Wilcox, Limited, will supply everything in connection with pulverised coal equipment on the Fuller system to all countries in the world, with the exception of the United States and its dependencies, also Canada and Mexico. They have already secured contracts for pulverised coal installations from the Castner-Kellner Alkali Company, Limited, the Rotterdam Electricity Works, &c., the contracts in each case including boilers, grinding mills, bunkers, feeders, burners and weighing apparatus. Messrs. Babcock and Wilcox, Limited, are also supplying pulverised coal installations on the unit system, and have in hand a plant of this type for the Solvay Company of Spain.

THE AUSTIN CONSTANT-CURRENT MOTOR FOR SHIP AUXILIARIES.

THE uneconomical nature of the ordinary steam-driven ship's cargo winch, windlass and steering engine has long been recognised, but it has proved difficult to suggest anything better. These appliances in their usual form owe their great practical success to the flexible nature of the steam engine, which if overloaded will simply stop, and can stand without inconvenience for an indefinite period with full load on. This qualification is of very great value for deck machinery, and has led to the almost universal survival of the steam deck winch and crane, in spite of the heavy steam consumptions for which they are responsible. This consumption is partly due to the nature of the appliances themselves, and partly to the losses arising from the long steam pipes by which they are served. These pipes are usually carried on deck, where they are in themselves an inconvenience and lead to heavy steam losses between the point of generation and the place of consumption. Placing the steam pipes below deck would no doubt reduce the losses due to condensation, but such a position is impossible in the ordinary cargo boat owing to the possibility of damage to cargo from leaky joints.

As an alternative to the steam engine, the electric motor would appear to have many qualifications for deck machinery, particularly in view of the elimination of steam pipes which would accompany the change. Unfortunately, however, the characteristics of the ordinary electric motor are not such as to meet well the conditions of service, and the actual amount of work that has been done in its application in this way is relatively small, although the advent of the Diesel ship has given a considerable impetus to the use of electrically-driven deck machinery. The backwardness of the electric motor in this particular application is probably essentially due to the fact that it cannot be stalled. It must be protected by fuses on an automatic circuit-breaker which will cut it off from the line in the event of overload. This protects the motor, but is an inconvenience in practice and makes the electric winch essentially less convenient for the arduous conditions of ship service. The speed control of the motor also introduces difficulties on shipboard owing to the resistances which have to be installed. These must be protected from the weather, and occupy valuable space, and although as energy wasters they are not comparable to the deck steam pipes of the steam winch, it is probable that many shipowners prefer the steam pipes as they do not take up any space which can be utilised for anything else. A further point in this general comparison which should be made is that the steam winch and its services are of a very simple nature as compared with a corresponding electric winch and its equipment.

The present state of affairs in relation to ship deck auxiliaries lends great interest to a new method for the electric driving of such applinnces, which has been introduced by Messrs. Gilbert Austin, Limited, of Cathcart, Glasgow. This method which combines many of the advantages of both of the older methods, appears of great promise and may well prove of very considerable importance. The essential feature of the Austin system lies in the use of a constant-current motor in place of the constant-voltage motor of current practice. The system carries all the advantages of electric distribution, eliminates complicated and bulky control gear at the actual machines, and offers a winch which can be pulled up under load, and can remain in that condition exerting full torque in exactly the same way as a steam winch or windlass.

A constant current system of electrical distribution was, of course, not unknown in earlier days and is still extant in the well-known Thury system of transmission. The Austin system is not, however, a mere application of any earlier method, and contains new features of great importance. In earlier constant current methods the constant current has been obtained from a generator with a movable brush rocker, the movement of which is controlled by a mechanically driven regulator, the regulator moving the brushes to compensate for any alteration in the resistance and counter E.M.F. in the line. The motors are controlled by moving the brushes in a similar way. It is clear that an apparatus of this kind is not likely to prove attractive for ship winches, and for the Austin system a constant-current generator has been developed which has fixed brushes and no moving parts whatever except the revolving armatures of the dynamo and its exciter. Similarly a motor on corresponding lines has been developed which has fixed brushes, and which is capable of variation in speed in either direction from zero up to as much as twice normal full speed, and with high efficiency at all speeds.

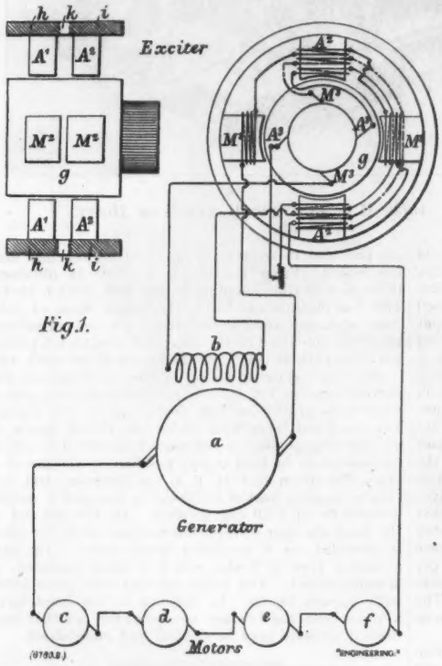


Fig. 1.

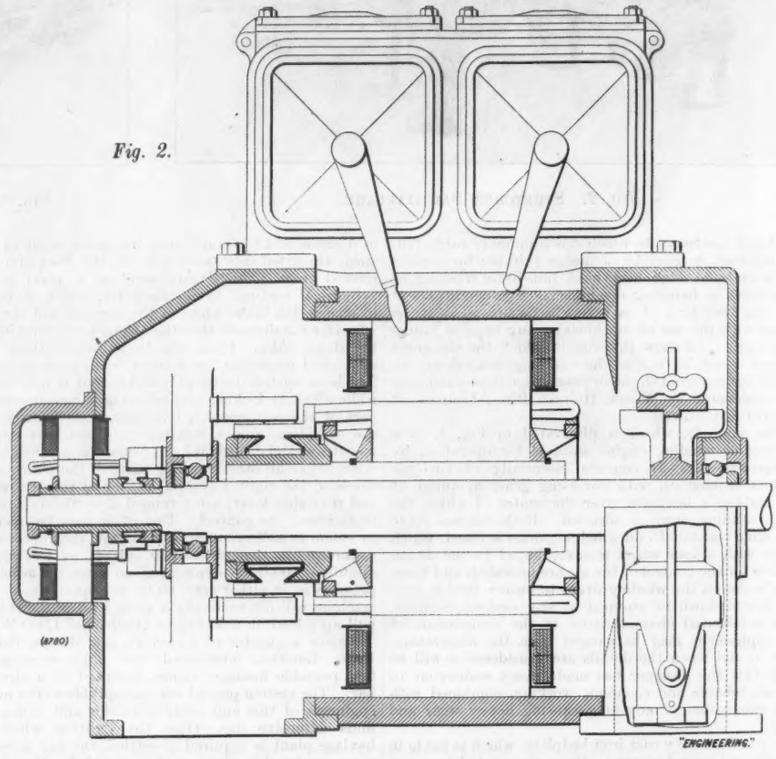


Fig. 2.

The Austin generator, which with fixed brushes is capable of producing a constant current and varying the voltage rapidly and automatically, according to the requirements of the external load, is shown diagrammatically in Fig. 1, above. The machine consists of an armature *a* and separately excited field coils *b*. Coupled to the generator shaft there is an exciter, which is shown in side view and end elevation in the upper part of Fig. 1. The sole duty of this exciter is to energise the independent field coils of the generator. At the bottom of the diagram four constant-current motors, *c*, *d*, *e* and *f*, are shown connected in the generator circuit. The exciter is provided with a single armature *g*, main poles M^2 and auxiliary poles A^1 and A^2, main brushes M^3 and auxiliary brushes A^3. The windings on the main poles carry the main current or a portion thereof, while the auxiliary poles are provided with three separate windings. These consist of (1) an exciting winding deriving its supply from the auxiliary brushes A^3, (2) a compensating winding in series with the generator field-magnet coils and deriving its supply from the brushes M^3, and (3) a stabilising winding carrying the main-line current. The auxiliary poles are split into the two portions A^1 and A^2, and the exciting and compensating windings embrace the whole pole and are connected to excite in the same direction. The stabilising winding is wound round one part of the pole in such a direction as to assist the other two windings, and round the other part in a direction so as to oppose these windings. The yoke is separated into two parts *h* and *i* by a ring of non-magnetic material *k*.

The action of the machine is as follows :—Currents flowing from the main and auxiliary brushes will create magneto-motive forces in the armature of the exciter in line with their respective brushes. The one in line with the main brushes will directly oppose the flux produced by the exciting winding on the auxiliary poles, while that in line with the auxiliary brushes will directly oppose the flux due to the winding on the main poles. As the magneto-motive force produced on the armature by the current from the main brushes opposes and weakens that of the exciting winding on the auxiliary poles, it is compensated by means of the compensating winding, wound on to auxiliary poles so as to assist the exciting winding. The stabilising winding is wound partly to assist and partly to oppose the other two windings, and the combination is such that one part pole is strongly magnetised and is not sensitive to small changes, while the other part pole is in almost a neutral state. It has, therefore, a high permeability and is supersensitive to the slightest change.

If the current flowing in the line is of such value that the flux from the main poles almost balances that in the armature, due to the current from the auxiliary brushes, then there will be practically no flux in the main poles, and therefore, only the very small voltage required to excite the generator fields under short-circuited line conditions, will appear at the exciter main brushes M^3. If, however, the line current falls slightly, a three-fold effect will be produced, tending to increase the exciter main field flux and, therefore, the field of the generator, as follows :—(1) The armature reaction magneto-motive force in line with the auxiliary brushes becomes greater than the magneto-motive force due to the exciter main poles, thus producing a residual magneto-motive force in favour of the armature. (2) The opposing magneto-motive force due to the stabilising winding on the auxiliary poles is reduced, thus further increasing the residual magneto-motive force of (1) by increasing the auxiliary brush current. (3) Due to the increase of the auxiliary brush current and the corresponding increase of the exciting magneto-motive force on the auxiliary poles, the auxiliary-brush current is further increased. This results in a still

greater increase of the residual magneto-motive force of (1).

This three-fold effect is obtained with great rapidity and with little or no mutual inductive action between the various adjacent windings. The arrangement operates in a reverse direction should the line current be increased instead of reduced. In the event of a sudden great increase in the line current the cumulative effect of the three windings on the one part pole operates to hold the machine in a stable condition by preventing the reversal of the magnetism of the auxiliary poles as a whole. The practical effect of the arrangements is that an ammeter placed in the main circuit shows practically a steady current similar in every respect to a voltmeter indicating the voltage on a constant-pressure system, while a voltmeter connected between the positive and negative terminals of the generator shows a voltage continually varying according to the load.

The motor which has been developed for use in conjunction with this constant-current generator is illustrated by a sectional view in Fig. 2, opposite. It consists of the combination of a large and small motor, the two armatures being on one shaft as shown. The small motor is known as the regulating motor. The line current passes through the armature of the main motor and the field winding of the regulating motor, while the armature of the latter is inserted in the exciting circuit. The exciting current passes through a variable potentiometer. This potentiometer, which contains the only resistance used, consists of two short lengths of alloy of large section, and is run at a low temperature. The energy used in the potentiometer and field winding together is not more than that used in the field winding alone of an ordinary motor. Speed control in either direction is obtained by moving the contact arm of the potentiometer, and the motor can be built to give a torque characteristic similar to a series, shunt or compound wound machine, with the great difference that an overload at any speed slows the motor down, and at speeds below normal full torque is maintained and even increased as the speed approaches zero.

It will be clear that this Austin system, apart from any other advantages we have mentioned, has the important qualification for ship auxiliary work that the wiring is reduced to a simple ring main with no external control wiring of any kind. As the motors are run in series, a two-way short-circuiting and disconnecting switch is fitted in connection with each motor. The voltage of a 15-h.p. Austin motor would be approximately 50, so that if the main circuit is limited to 650, which is the Board of Trade limit for medium pressures, as many as 13 such motors could be connected in series on the line. This is more than would usually be necessary, but with higher power the voltage demanded is greater, being about 65 volts for 20 h.p. It will be clear, however, that the system is likely to meet the conditions of the average cargo boat easily, while, for large liners, two or more independent circuits each of 650 volts would be allowable. A detailed discussion of this interesting system was contained in a paper entitled "A New Electric Drive for Ship and other Auxiliaries," read by Mr. Gilbert Austin before the Institute of Engineers and Shipbuilders in Scotland on the 18th inst.

THE JAPANESE TRAIN-FERRY TURBINE STEAMER "SHOHO-MARU."

The first Japanese self-propelled ferryboat equipped with rails for the accommodation of freight cars is illustrated on Plate LXXVII, which accompanies our issue of this week. Four such vessels have been ordered by the Imperial Japanese Railways for cross-channel service between Aomori, on the mainland, and Hakodate, Hokkaido. A contract for the construction of two such ships was placed in 1922 with the Uraga Dock Company, which possesses one of the largest shipyards in Japan, the other two steamers being at present building at the Nagasaki works of the Mitsubishi Shipbuilding Company, another leading yard in the country. The first vessel, the Shoho Maru, has now been completed by the former firm in accordance with the Japanese Government Inspection Rules, under the supervision of the Chief of the Marine Department of the Imperial Japanese Government Railways.

A profile of the Shoho Maru is shown in Fig. 1, the main dimensions and other particulars being: length over all, 360 ft.; length between perpendiculars, 350 ft.; moulded breadth, 52 ft.; and moulded depth to wagon deck, 22 ft. The height between the main deck and wagon deck is 7 ft. 9 in., between the wagon deck and lower promenade deck, 8 ft.; between the lower promenade deck and upper promenade deck, 8 ft.; from the latter to the boat deck, 8 ft.; and between the boat deck and the navigation bridge, 8 ft. The loaded draught is 15 ft., while the gross tonnage is 3,461.

The arrangement of the boat deck is shown in Fig. 2. Extending to nearly four-fifths of the length of the ship this deck has flying bridges at the fore and aft ends, that at the fore end carrying the navigation bridge. Ten lifeboats and one temma (Japanese sampan) are mounted, all of which are controlled by means of electric winches operating through Welin's davits. At the fore end of the deck the quarters for the captain and officers are constructed, and also a wireless installation cabin. From the aft flying bridge, which completely spans the breadth of the deck, the handling of wagons may be supervised. Figs. 3 and 4 show the navigation bridge and the compass platform, the former carrying two fresh and one sanitary water tank. The plan of the upper promenade deck is shown in Fig. 5, and it is seen that the living quarters of the first and second class passenger are situated here. The state rooms, first-class smoking room and the restaurant are placed forward, and the second-class smoking room at the port side, of the funnel. Second-class sleeping accommodation is provided at both sides of the engine hatch. The dining saloon is lighted by means of bay windows on both sides of the room, and by a stained glass skylight. The floor is rubber tiled. Up to 28 passengers can dine simultaneously. Located at the forward starboard side of the dining room is the first-class smoking room, equipped with an electric fire. The second-class smoking room aft of the dining room, at the port side, is decorated in dark green.

The arrangement of the lower promenade deck is shown in Fig. 6. As can be seen the deck is not complete, but consists of shelving round the sides of the vessel. Since only 8 ft. separates this deck from the lower one, the central portion has been omitted to permit of the wagons, carried below, having a height exceeding this distance. The deck is used exclusively for quarters for the ship's complement, the crew's rooms being at the fore part of the vessel, while the engineers are located at the starboard side amidships. In Fig. 7 the wagon deck—the main feature of the vessel—is shown. Two wing tracks extend the full length of the deck, a third in the centre reaching to the funnel casing. The rails weigh 75 lb. per foot run, and are of the flanged type.

The maximum wagon load is 575 tons, made up of 20 fifteen-ton freight wagons on the wing tracks and 5 similar cars on the centre track. The tracks are well filled even with variations in the loading, and as will be seen, two brake vans are shown replacing 5 cars in Fig. 6. At the forefront of the deck provision is made for the engine room complement, a high standard of accommodation being maintained. In Fig. 10 a general view of the wagon deck is given.

The main deck, shown in Fig. 8, is divided into two parts separated by machinery bulkheads amidships. Steering engines are fitted at both the fore and aft ends of the main deck as the boat is fitted with rudders both at the bow and stern to facilitate movement in confined water. These rudders are separately manipulated by bow and stern steering engines through a telemotor system. The stern rudder can also be worked by either of two steam capstans installed at each side of the main deck. The latter carries the mail room, baggage room, and steerage passenger quarters at both ends, these being furnished with tatami (Japanese matting). The vessel is constructed with a cellular double bottom, extending from the fore to the after peak, and is transversely divided by six water tight bulkheads extending to the wagon deck. Besides the double bottom, special trimming tanks, each of 100 tons capacity are provided on both sides of the boiler space, water filling and discharging operations being controlled and manipulated by an electric motor operated from the navigation bridge. The quantity of water in the wing tanks may be measured by means of pneumercators, made by the Pneumercator Company of New York. A general view of the vessel is shown in Fig. 9.

The vessel's propelling machinery consists of two sets of single-reduction geared impulse turbines of the Metropolitan-Vickers Rateau type, each set having high-pressure and low-pressure cylinders. The blade material throughout is of 5 per cent. nickel steel. The velocity blades are secured to the rotor wheels by dovetailing into grooves, while the impulse blades are secured by double rivets with straddled roots. The turbine sets drive two propellers which rotate outwards in opposite directions, the aggregated maximum estimated shaft horse-power being about 6,000, giving a speed of 17 knots. The six boilers are of the single-ended cylindrical coal-burning type, having a length of 11 ft. 6 in., and a mean diameter of 14 ft. 3 in. They are provided with three Morison suspension furnaces, and have a working steam pressure of 200 lb. per square inch, with 120 deg. F. superheat. Howden's forced system of draught, with closed ashpit, is adopted. The heating surface is 2,348 sq. ft., while the grate area is 6,075 sq. ft. Minorikawa's patent fire bars are fitted. Two sets of See's patent ejectors, with a powerful simplex pump, dispose of ashes. The main condensers are of the Contraflo type having a cooling surface of 2,878 sq. ft. They are fitted under the low-pressure turbines, suspended athwartship. The propellers have bronze blades, and are 10 ft. 9 in. in diameter, having a pitch of 11 ft.

Forced lubrication is arranged for in the reduction gearing by means of three sets of Mumford's patent simplex pumps and three large coolers placed in series. A kinetic reciprocating air pump is provided for each set of turbines. The power of the latter is determined by using Dr. Suehiro's patent torsion meters, which are fitted. Lighting and wireless service is maintained by two 20-kw. dynamo sets installed in the engine room, all other auxiliaries, deck machinery and equipment being in accordance with general practice on first-class passenger steamers.

The vessel can accommodate 39 first-class passengers in state rooms, and 208 second-class passengers, 28 of whom can be accommodated with sleeping berths; 648 third-class passengers can also be carried. The ship's complement is 128, so that the total number of persons carried is 1,023. The deadweight capacity is 960 tons. Fine weather and a smooth sea favoured the official trial held in March last. During this trial the mean draught was 15 ft., the displacement 4,529 tons, and the immersed midship area 725 sq. ft., the total wetted surface being 19,060 sq. ft. The mean of six single runs gave a maximum speed of 16·957 knots, with the propellers averaging 190 r.p.m. The shaft horse-power was 5,730, and the boiler pressure 200 lb. per sq. in. A vacuum of 28·375 in. was maintained. On Japanese coal the consumption per shaft horse-power per hour of the turbines was 1·234 lb.

The second vessel, the Hiran Maru, is due from the Uraga yard shortly.

WATER SUPPLY TO THE SMALLER PROVINCIAL TOWNS OF EGYPT.*

By Reginald Humphrey Lee Pennell, Assoc. M.Inst.C.E., and Herbert Addison, B.Sc., Assoc. M.Inst.C.E.

The paper describes the evolution and final perfection of a comparatively inexpensive plant for the clarification and purification of water for town supplies. The work described was all carried out in Egypt, the Egyptian Government supplying the necessary financial credits each year. The Nile river during flood carries 1,500 parts per million of solids in suspension, and the experimental work in the first instance was confined to the clarification of this water. The basis of the design of the plant was to treat the water by means of roughing filters, and to treat it in stages, since the difficulty foreseen was in the cleansing of the filters.

The plant as first erected consisted of a central vertical inlet-pipe discharging through a specially shaped orifice, to aid aeration, into a small well from which the water passed into a small settling-tank. The well discharged into the settling-tank near the floor, and the settling-tank discharged at the top. The settling-tank was circular, and surrounding it were three roughing filters, which have been named "scrubbers," filled with 4- to 6-in. stones, resting on perforated false floors. The scrubbers worked in series, by upward filtration. The water entered below the false floors, passed upwards through the stone, and discharged from the surface to below the false floor of the next filter in the series. Surrounding the scrubbers were a further series of three filters, or "strainers," followed by sand filters. The strainers were larger than the scrubbers and were filled with a finer filtering medium. Coarse gravel was tried at first. Otherwise they were of similar construction to the scrubbers and worked in series in the same way. On leaving the strainers the water passed by downward filtration through the sand filters. The washing of the settling-tank and prefilters was effected by opening large plug valves in the floors and allowing the water to flow back rapidly through the gravel and escape through these valves. The sand filter was washed by pumping water into the filter below the sand in the usual manner.

The large-size medium proved unsuccessful—it was found to be better than none at all, but it did not wash well. It has been expected that a coarse medium would wash more easily than a fine medium. A long series of tests were carried out with various grades of filtering medium, and are described in detail in the paper. These tests finally led to the adoption in the strainer of a very fine gravel of 96 grains per inch and in the scrubbers of gravel of 46 grains per inch.

The settling-tank was enlarged and the scrubber-area was reduced by converting one scrubber into an additional settling-tank. It was found better to filter slowly through a few stages rather than to filter faster through many stages. The two scrubbers and

* Abstract of a paper to be read before the Institution of Civil Engineers on Tuesday, December 2, 1924.

the strainers were therefore arranged to work in parallel, and the final arrangement thereby came to be a settling-tank, a scrubber, and a strainer. The scrubber and strainer were divided into compartments in order to facilitate washing. The clarification was perfect with the setting-tank of ¾ hour pumping-capacity, combined with a rate of filtration through the scrubbers of 10½ ft. per hour and through the strainers of 4½ ft. per hour. Owing to the very fine nature of the silt in the water a coagulant was necessary and alumina sulphate was added, the proportion of which never exceeded 90 per cent. of that used at the same time of year in settling-tanks of 8-hour capacity. Even with this 10 per cent. more alum, 8-hour settling-tanks were not nearly so efficient.

Experiments on sterilization by chlorination were then carried out, the object being to avoid the cost of the usual acid treatment for the removal of excess chlorine. The chlorine was derived from bleaching-powder. The chlorination plant consisted of four tanks, each of which took 30 min. to fill. Each tank was fitted with an air bell and small chlorine dosing-tank above it. As a tank filled with water, the chlorine solution was discharged from the dosing tank by air-pressure engendered in the bell by the rising water. When the tank emptied, the reverse process took place, the vacuum formed drawing the chlorine up into the dosing tank and filling it. All the chlorine pipes were large, and there were no cocks or orifices to get out of order or choke. An automatic arrangement controlled by floats opened the inlet and outlet valves of the four tanks in series. Since each tank took ¼ hour to fill, each tank remained full and quiescent for 1 hour before it emptied. The chlorine solution was of a strength to furnish 1 part per million of free chlorine to a tank full of water. Since the water from the clarifier was quite clear, this quantity of chlorine absolutely sterilized it. Before the hour elapsed and the tank discharged, the chlorine had been entirely oxidised, and there was no taste whatever. The plant was simple and very satisfactory.

The paper also describes the sand filter, which was designed to avoid the cost of mechanical rakes or the use of compressed air to aid the washing. The design of the false floor appeared to govern the first condition. After three separate attempts an entirely satisfactory floor was evolved by constructing it in the form of a series of pressure-diffusion chambers and leading the water to these chambers through a series of pressure-diffusion pipes. The filter washed well without any extraneous aid beyond the use of an ordinary garden rake to disturb the top few inches of sand.

The controller, required to maintain a constant rate of filtration, as first designed consisted of an orifice discharge, the orifice being at the bottom of a tank into which the filter discharged freely. A needle in the shape of an inverted cone carried by a float descended through the orifice and partially closed it. As the head in the filter increased, the water in the tank fell, taking the float with it. The water passage was thereby automatically suitably increased to maintain the same discharge, owing to the taper on the float. This controller operated well, but the special profile was found to be expensive. A cylindrical perforated needle was next evolved. The necessary increase in the area of the orifice as the needle descends was obtained by passing some of the water through the interior of the needle by means of the perforations. The needle, excepting for drain holes, is closed at the bottom and the water enters freely in the plane above the orifice, discharging through the perforations below the plane of the orifice. As the needle falls, the discharge-head is decreased, but the number of perforations below the orifice is increased. A constant discharge is thereby obtained. Owing to its simplicity, the perforated-needle type of controller is suitable for regulating the flow of water in large quantities—for example, in irrigation work, when it is desired to pass only a definite quantity of water into a subsidiary canal independently of the level of the water in the main feeder.

The experimental work in the design of the controllers was carried out at the School of Engineering, Cairo, by the kind permission of Abdel Mageed Omar Bey, M.Sc., Assoc. M.Inst.C.E.

RESEARCH LABORATORIES AT HENLEY'S CABLE WORKS.

Research now forms such an important adjunct to the manufacture of even the most commonplace objects, that it obviously cannot be neglected in cases where the utility of the product is mainly dependent upon the quality of the materials and their treatment in the factory. The manufacture of cables for telephone lines, telegraphy and power transmission, is a particularly good example of industrial work for the successful conduct of which research is essential at the present time, since the technical advances made in other branches of electrical engineering are constantly making further demands upon the products of the cable maker. From the earliest days, the value of research work in their business as cable manufacturers, has been fully appreciated by Messrs. W. T. Henley's Telegraph Works Company, Limited, and has been an important consideration in the technical administration of that concern. The changed conditions of the last few years, however, have called for more special treatment than was formerly necessary, a highly trained staff, with adequate accommodation and equipment, being now regarded as essential for the solution of the complex problems arising in their work.

The firm therefore decided, about three years ago, to build and equip a research laboratory adjoining their Gravesend wire drawing and cable-making works, and to carry out in this laboratory the whole of the research work both for the Gravesend works and for their other works at North Woolwich. The whole research installation, which we have recently had an opportunity of inspecting, has been completed within the past few months and is now in full operation. As a rough guide to the activities of the laboratory, we may say that the equipment is designed for testing the quality of the raw materials used (the principal materials being copper, paper, oil, lead and rubber), and also for finding new and improved materials for use in cable manufacture. Another branch of the research work relates to processes used in the works, such as impregnation. The arrangements have been designed to permit such processes to be carried out under exactly controlled conditions in a small scale laboratory and also to enable the effect of transferring the operations to the practical conditions existing in the factory to be determined without disturbing the normal production. The compilation of technical information, which is indexed for reference, is also carried out in the research laboratory, the data being supplied to the various departments of the firm which are likely to be interested, and also used for answering the many enquiries submitted by clients. It may here be mentioned that the investigations carried on in the laboratories are of a utilitarian character, and are such as are considered likely to give immediate results in their practical application in the works; no purely academic research work will be carried on, although its value is by no means underrated.

The building in which the new laboratories are

RESEARCH LABORATORIES AT HENLEY'S CABLE WORKS.

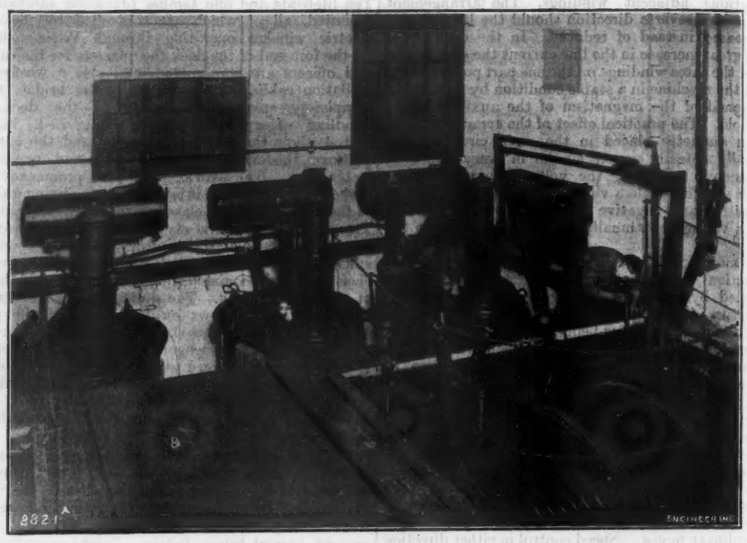


Fig. 1. High-Tension Testing Transformers and Cable Tanks.

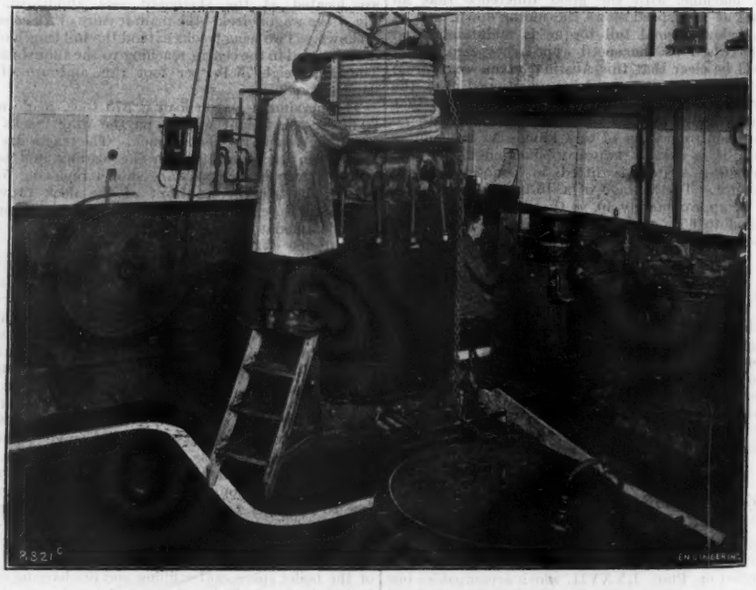


Fig. 2. Experimental Impregnating Plant.

RESEARCH LABORATORIES AT HENLEY'S CABLE WORKS.

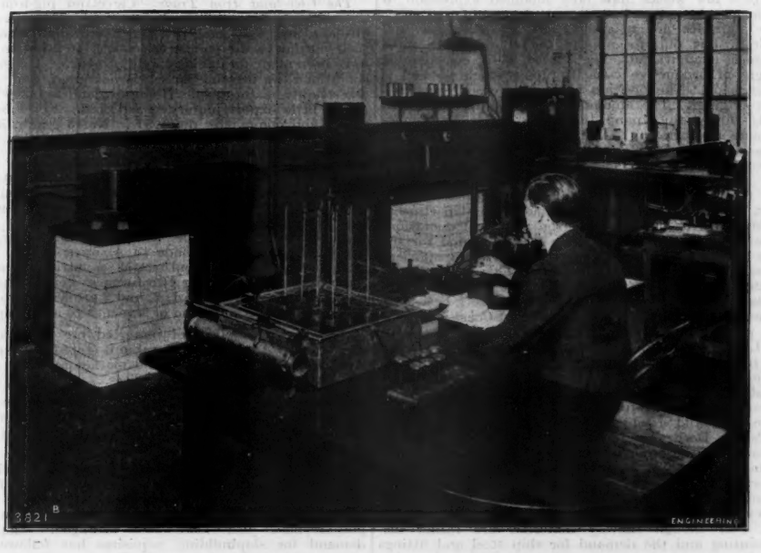


FIG. 3. TESTING APPARATUS FOR IMPREGNATING COMPOUNDS.

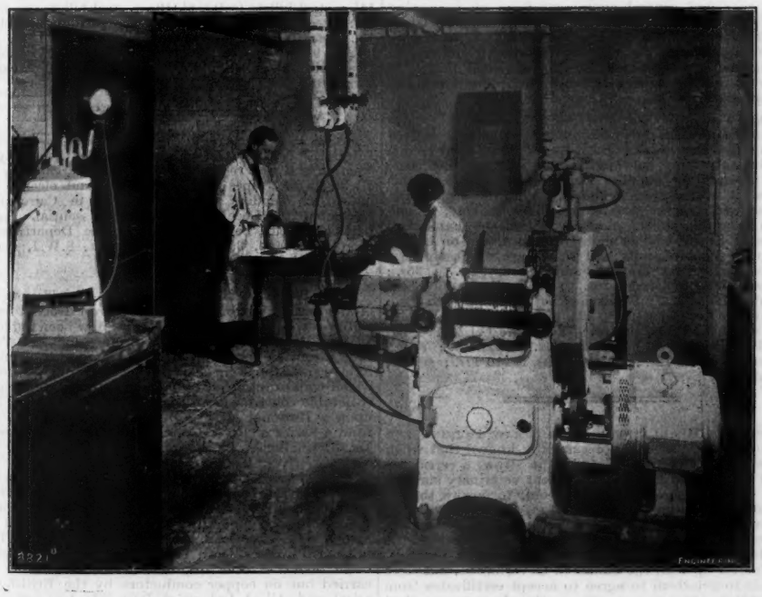


FIG. 4. EXPERIMENTAL RUBBER LABORATORY.

housed is a two-storeyed structure of steel and brickwork, with a ferro-concrete floor and a flat roof. It is situated on the banks of the Thames and has a total floor area of 14,000 sq. ft. A central corridor on each floor gives access to the rooms, which are arranged along the sides and at each end. Heavy machinery and apparatus likely to be affected by vibration, are located mainly on the ground floor, while the chemical laboratories, library, offices, &c., are situated on the first floor. Each room is supplied with water, gas, steam at 60 lb. per square inch, and air at 15 lb. per square in., numerous connections being provided, and vacuum and high-pressure pumps are also installed, with special connections where needed. Electric power is supplied to the building at 6,600 volts, the total requirements for all purposes amounting to about 350 kv.-a. By means of a rotary converter and specially arranged switchgear and circuits, the various laboratories are supplied with three-phase current at 440 volts and direct current at 110, 250, and 500 volts. In addition, a 110-volt battery, of 800 ampere-hours capacity, has been installed, the wiring being arranged so that any voltage between 2 and 110 can easily be connected to any room.

One of the most interesting features of the laboratory, at all events to visitors, is the high-tension room which is situated at one end of the ground floor, and is used for the measurement of dielectric losses, and for the application of high-voltage tests to finished lengths of cable. Three single-phase testing transformers, illustrated in Fig. 1 opposite, supply the high-tension current, their primaries being fed at 500 volts from a three-phase motor generator of 225 kv.-a. capacity, operating through three regulating transformers. The secondary voltage of each of the testing transformers is 125,000, but the insulation resistance to earth has been designed so that, by suitable connections, a three-phase current at 210,000 volts can be obtained, or, by connecting the three transformers in series, a single-phase current at 375,000 volts can be produced. Of the many interesting features embodied in the design of the plant, we may mention that the voltage regulator of the high-tension transformers is automatic, being operated by a motor controlled by a series of push buttons. It should perhaps be explained that, in breakdown tests, the rate of increase in voltage greatly affects the results, so that provision has been made for raising the voltage, by means of the push buttons referred to, at any one of four different rates. The main transformers, as shown in Fig. 1, are installed in pits to economise head room and to facilitate the changing of connections. The cable tanks, which can be seen in the foreground of the illustration, are 8 ft. deep and are heat lagged, so that tests can be carried out at temperatures up to 90 deg. C. on lengths of cable wound on drums. The illustration also shows the form of connection used for testing three-core cables, its object being, of course, to prevent flashing over at the ends, which is one of the chief difficulties encountered in carrying out these tests.

Adjoining the high-tension room is a workshop equipped with lathes, shapers, drills, &c., used for making special apparatus employed in the laboratory, and opposite the workshop is the room in which investigations connected with factory processes are carried out. As will be readily appreciated, it is frequently desirable to conduct such experiments on a more limited scale than would be possible in the works, where to try out a new impregnating compound, for example, would involve the use of from 10 tons to 20 tons of material. At the same time, the results obtained from tests on samples of a gallon or so are not sufficient to justify the employment of the material on a manufacturing scale. For this reason, the room just mentioned has been allocated for the purpose of carrying out works processes on an intermediate scale. The usual practice is to bring the machines from the works to the process room, as required for any particular investigation, and to return them on the completion of the work. An experimental impregnating plant, however, is permanently installed in the room, and this plant is illustrated in Fig. 2, on page 736. The same room houses a 100-ton hydraulic testing machine for tension and compression tests. An interesting point in connection with this machine is that tensile or compressive loads, up to about 10 tons, are measured by the extension or compression of a steel tube, through which the load is transmitted. The tube is filled with mercury, which rises or falls in a glass tube communicating with the steel tube as the volume of the latter is diminished or increased, by the application of the load. Higher loads are determined from the water pressure in the hydraulic ram.

For tensile tests on rubber, paper, wire, &c., a standard Schopper quadrant-type testing machine is installed in the physical-testing laboratory on the ground floor, as also is a specially-designed machine for measuring the force required to tear the paper used for cable manufacture. On the occasion of our visit, a special test had been arranged in this laboratory to illustrate the influence of fibre, and other foreign matter, on the insulation breakdown tests of oil. By optical projection it was shown that the electrostatic field between the discharge balls was sufficient to draw any fibres floating in the oil into the spark gap, where their presence would materially reduce the voltage required to produce a discharge. The microscope, of course, is largely employed for the examination of paper and metals and a laboratory well equipped with visual microscopes and photomicrographic apparatus, is devoted to this work. A photographic dark-room adjoins this laboratory, the entrance to the dark-room being arranged in the form of a light trap so that persons can enter and leave it at any time without admitting daylight.

The only other important room on the ground floor is known as the low-tension laboratory, and is used for dielectric resistance tests on cables, oils and impregnating compounds, viscosity measurements, and for conductivity tests on copper, which is supplied to the works in the form of rolled rods about $\frac{1}{4}$ in. in diameter. For the conductivity tests, the method suggested by the United States Bureau of Standards has been adopted, in which the conductivity is deduced from measurements of the temperature coefficient of resistance made with a Kelvin bridge on specimens contained in a heated oil bath. The method has the obvious advantage that it requires no knowledge of the actual dimensions of the specimens and can therefore be applied to bent or twisted rods of irregular section. The apparatus for resistance tests of impregnating compounds is illustrated in Fig. 3 on this page, the illustration also showing the method of mounting the reflecting galvanometers on brick piers; these are carried down for a distance of 6 ft. below the floor level into the solid chalk which forms the subsoil of the locality. The same room is provided with a primary battery from which any voltage up to 1,000 can be obtained for direct-current tests, and the equipment also includes apparatus for telephone cable testing and for rating tests of switches and cut-outs, which form an important item of the firm's products.

The chemical laboratories, as previously mentioned, are located on the upper floor and are used for acceptance tests on raw materials, control tests on materials in the course of manufacture, and for the chemical work required in connection with the investigations carried out in the research laboratory; a small separate laboratory is provided with the necessary furnaces of various types for heat-treatment work.

For investigations in connection with the production of tyres, golf balls and tennis balls, which are made by an allied company, a small laboratory on the upper floor has been equipped with a mixing mill having steam-heated rollers, a vulcanising press and the necessary accessory apparatus for making up experimental batches of rubber, or test samples of gutta percha, under controlled laboratory conditions. In this laboratory, which is illustrated in Fig. 4, it is possible to study the effect of various ingredients and of different vulcanising times, and also to produce rubber sheets from which specimens can be cut for testing on the Schopper tensile testing machine referred to above.

Mention should be made, in conclusion, of another important room on this floor, viz., the library, in which technical literature and information relating to the company's different activities is stored for ready reference. It is also used as a conference room for the staff, and is provided with an optical lantern and fixed screen for use by lecturers. The whole research organisation is under the control of Mr. P. Dunsheath, to whom we are indebted for the information from which the foregoing description of the laboratory has been prepared.

SALT CRYSTALLISATION.

Two papers on crystallisation were discussed by the Chemical Engineering Group of the Society of Chemical Industry on a recent date. The first, by Mr. T. V. Barker, on "The Development and Formation of Crystals," dealt with the problems in a way instructive even for those familiar with recent work on crystal structure and Röntgen rays. The conclusion which Mr. Barker drew was that X-ray researches would not teach us why certain crystal faces develop (or are dissolved) in preference to others; the study of surface tension phenomena in their various aspects might help us to understand these problems.

The other paper on "Mechanical Crystallisation," by Mr. Hugh Griffiths, might have been more technical than as he presented it. He referred to the old-fashioned idea that solutions to be crystallised must be cooled very slowly and be left perfectly quiet, which is only suitable in special cases, and to Sir Henry Miers' distinction of the ordinary solubility curve and the super-solubility curve; the region between the two curves being in unstable equilibrium marked the range suitable for crystal growth. Miers studied the concentrations of crystallising solutions on the microscope stage by observing the refractive index of the solution. His researches were of great value, but his experimental conditions can hardly be compared with those prevailing in the crystallisation pans of sugar and salts, and with the conditions of solidifying igneous rocks and ores, which the Faraday and Geological Societies had been discussing the previous evening. One feels a little doubtful, therefore, as to the significance of Mr. Griffiths' distinction, based upon the Miers curves, of crystallisation by slow or rapid cooling, in the absence or presence of seeding crystals, by controlled cooling, vacuum cooling and by evaporation. Substances are crystallised and recrystallised for various purposes. Fancy for shape or colour may be a factor; certain candy crystals are actually coloured now, because the people insist upon a brownish tint, and large crystals are crushed so as to make them saleable as individual crystals. Prevention of subsequent caking is another important object. Agitation prevents the agglomeration of crystals during their growth and requires control of temperature and concentration. Mr. Griffiths recommended agitation in rocking troughs, as first introduced by Wulff and Bock. The solution is fed in at one end of the trough, which may be 50 ft. and even 100 ft. long, and is discharged at the other. Those troughs must be mechanically very stiff and strong, and they are provided with baffles to minimise longitudinal vibrations. One of the advantages of the mechanical agitators is that they admit of continuous discharge without avoidable manual labour.

INSTITUTION OF NAVAL ARCHITECTS.—The following scholarships will be offered for competition in 1925: Naval Architecture: "Elgar" Scholarship (130*l.* per annum) and "Armstrong" Scholarship (150*l.* per annum). Marine Engineering: "Parsons" (150*l.* per annum), "Yarrow" (100*l.* per annum), and "Denny" (75*l.* per annum, open to boys, British subjects, from approved public schools or schools under the Education Authorities). With the exception of the last-mentioned, these scholarships are open to British apprentices or students who have not yet entered upon a university course, and are tenable (subject to the regulations governing each scholarship) for four years at Glasgow University, and for three years at Durham University (Armstrong College), Liverpool University, the Royal Naval College (Greenwich), and the City and Guilds (Engineering) College. Full particulars may be obtained from the Secretary, Institution of Naval Architects, 5, Adelphi Terrace, London, W.C. 2.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—The improved tone reported within the past few weeks finds only modified expression in the market for raw and semi-finished materials. Rather more inquiries are in circulation for hematites and pig-iron, but outputs appear to be ample to meet contract commitments, and there is a considerable margin of productive capacity upon which no call is being made. The position as regards crude steel is a little brighter. The amount of business in circulation tends slowly to expand, with the result that more furnaces are operating than before the set-down recently caused by the strike of semi-skilled operatives for improved wages and conditions. Stocks both of iron and steel at manufacturing works are, however, so low that any improvement in the finished sections must confer a corresponding benefit on departments dealing with basic supplies. Iron and steel quotations as latest revised are lower than at any period for the past 12 months, and will, it is hoped, prove a sufficient inducement to users to cover themselves more freely in the matter of forward deliveries. Compared with a year ago steel billets, both hard and soft basic, are 1*l.* per ton cheaper, West Coast and East Coast hematites 15*s.* per ton cheaper, and forge and foundry iron from the Lincolnshire and Derbyshire furnaces 10*s.* to 12*s.* 6*d.* per ton cheaper. Current prices are as follows: Hard basic steel billets 9*l.*, soft basic steel billets 8*l.*, West Coast hematites 5*l.* 5*s.*, East Coast hematites 4*l.* 10*s.*, Lincolnshire No. 3 foundry iron 4*l.* 5*s.*, Lincolnshire forge iron and Derbyshire No. 3 foundry iron each 4*l.* 2*s.* 6*d.*, Derbyshire forge 4*l.*, bars 13*l.* and sheets 15*l.*, in each case per ton delivered at local works. In the engineering trades the more hopeful outlook recently reported is endorsed in the official journal of the Sheffield Chamber of Commerce which points out that the local heavy and medium industries seem to be improving, and that though railway materials are rather disappointing and the demand for ship steel and fittings is not yet broadening very much, in both these branches there are high prospects of coming activity. The same authority states that castings are in fair demand. Pithead gear and general equipment form an improving line. Structural steel is at least more moderately healthy. Substantial foreign and colonial demands are anticipated shortly for railway material, tramway and general municipal fittings, gears for electrical and water schemes, and machinery for sawmills, pulp works and coal mines.

South Yorkshire Coal Trade.—So far as actual quotations are concerned the position has undergone no change during the past week. Business in house coal is disappointingly slow considering the time of the year. The pressure for supplies usually experienced at this season is scarcely in evidence. A spurt during the closing weeks of the year is not at all unlikely, though there is nothing at the moment to indicate that it will happen. Steam coal is slightly more active on export account. Cobbles, nuts and slacks are all featureless. Quotations: Best branch hand-picked, 32*s.* to 35*s.*; Barnsley best Silkstone, 26*s.* to 28*s.*; Derbyshire best brights, 27*s.* to 32*s.*; Derbyshire best house, 24*s.* to 26*s.*; Derbyshire best large nuts, 22*s.* 6*d.* to 25*s.*; Derbyshire best small nuts, 14*s.* to 16*s.*; Yorkshire hards, 20*s.* 6*d.* to 23*s.*; Derbyshire hards, 20*s.* 6*d.* to 22*s.* 6*d.*; rough slacks, 9*s.* 6*d.* to 12*s.*; nutty slacks, 9*s.* to 11*s.*; smalls, 5*s.* to 7*s.* 6*d.*

CANADIAN REGULATIONS AS TO STRAW PACKING FOR GOODS.—It is, perhaps, not generally known that when goods are sent to Canada packed in straw, a certificate must be obtained from a government veterinary surgeon that the straw has been disinfected, to ensure that it cannot be the means of spreading foot-and-mouth disease. Unfortunately for traders, no government veterinary surgeons were available at the time of framing the regulations. The Federation of British Industries took the matter up with the Canadian Government, but were unable to get them to agree to accept certificates from any veterinary surgeon. They, therefore, approached the British Ministry of Agriculture, who have at their request nominated veterinary surgeons in various areas in the country, to grant certificates to meet the Canadian Government requirements.

THE BRITISH CORPORATION RULES AND TABLES.—We have received from the British Corporation for the Survey and Registry of Shipping, a copy of the latest issue of their Rules and Tables. Amongst the changes, we note an alteration in the framing formulæ which makes for simplicity. Amendments have been made in the requirements for engine and boiler casings, hatches and other features which are affected by freeboard regulations, to bring them into line with the latest recommendations of the Load Line Committee. In the scantling tables, the main alterations refer to the thickness of shell plates which are now expressed in hundredths of an inch. It should be noted that the new tables are in close agreement with the standards proposed by the 1914 Committee. Thicknesses of plate keels have again been slightly reduced amidships. The rules relating to machinery have been augmented by the addition of a new section on watertube boilers, shafts and tubes, and a complete review of the regulations governing the construction of internal-combustion engines. A new section of the book deals with the requirements for periodical surveys of vessels engaged on the Great Lakes of America. Throughout the whole work there are indications that the British Corporation intend to maintain the reputation they have already of keeping abreast of modern technical progress.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Cleveland pig-iron producers are in a very strong position. They have no unsold stocks, and some of them have fully disposed of their output to the end of the year. In addition sales have been made for delivery well into 1925. Under such conditions the pressure to sell is not great, and values are steadily maintained. Home demand is fairly good, and a little export inquiry is reported. No. 1 is very scarce and commands quite 87*s.* No. 3 g.m.b. is also scarce and is quoted 82*s.*; whilst No. 4 foundry is put at 81*s.*; and No. 4 forge is 80*s.*

Hematite.—The moderate business passing in East coast hematite more than absorbs current output and consequently stocks, though still large, are being gradually reduced, and producers are disinclined to make price concessions. Home needs are increasing, and small sales have been made to America as well as to Germany and other Continental countries. There is some likelihood of one or two furnaces being re-kindled in the near future. Nos. 1, 2, and 3 are 88*s.* 6*d.* to 89*s.*, and No. 1 is at a premium of sixpence to a shilling.

Foreign Ore.—Sellers of imported ore are taking a firm stand. A cargo of best rubio is stated to have been sold at 22*s.* 9*d.*, but recognised market rates are based on best rubio at 22*s.* 6*d.* c.i.f., Tees.

Blastfurnace Coke.—Durham blastfurnace coke is, if anything, a shade stiffer, but supply continues very ample, and good average qualities are still obtainable at 25*s.* delivered here.

Manufactured Iron and Steel.—In most branches of manufactured iron and steel a more hopeful feeling prevails. Inquiries are reported larger and more numerous, and several contracts for deliveries over periods next year have been arranged. Improved demand for shipbuilding requisites has followed the placing of one of two orders for steamers, and there has been some purchasing of railway material, and constructional steel. Common iron bars are 12*l.*; iron rivets, 14*l.*; steel billets (soft), 8*l.* 10*s.*; steel billets (medium), 9*l.*; steel billets (hard), 9*l.* 10*s.*; steel boiler plates, 13*l.*; steel ship, bridge and tank plates, 9*l.* 15*s.*; steel angles, 9*l.* 10*s.*; steel joists, 9*l.* 10*s.*; heavy sections of steel rails, 9*l.*; fish plates, 12*l.* 10*s.*; and galvanised corrugated sheets (No. 24 gauge, in bundles), 18*l.*

STEEL RESERVOIR FOR EGYPT.—The Ministry of the Interior, Egypt, has called for tenders for the supply and erection of a steel reservoir of 300 cub. m., capacity with all steelwork, pipes and accessories, and electric level indicator. Tenders will be received in Cairo up to December 28. Local representation is essential. Further particulars can be obtained from the Department of Oversea Trade, 35, Old Queen-street, S.W.1, quoting reference A.X. 1501.

CIVIL ENGINEERING IN IRELAND.—The Transactions of the Institution of Civil Engineers of Ireland for the eighty-seventh session, 1922–3, have now been published. In the Presidential Address, Professor P. F. Purcell drew attention to the unsatisfactory practice of inviting foreign assistance in carrying out works in Ireland which could quite well be performed by Irish engineers. A notable contribution to the volume is entitled "Notes upon a Rational Method of Eliminating Flood Effects from a Series of River Gaugings," and was prepared by Mr. J. Challoner Smith.

SPECIFICATION FOR HARD-DRAWN COPPER CONDUCTORS.—The British Engineering Standards Association has recently issued publication No. 125–1924, giving a "Specification for Hard-Drawn Copper, Solid and Stranded Circular Conductors for Overhead Power Transmission Purposes." In compiling this, advantage has been taken of the information available from tests carried out on copper conductors by the British Electrical and Allied Industries Research Association, and by the National Physical Laboratory staff. Copies of this specification may be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W.1, price 1*s.* 2*d.*, post free.

THE VELOCITY OF LIGHT.—In a recent address to the Franklin Institute, Professor A. A. Michelson described the results obtained in the last determinations of the velocity of light. The value of this fundamental constant has been repeatedly measured and the mean value of previous determinations was 186,330 miles per second, with an uncertainty of 20 to 30 miles. In view of the great scientific importance of this velocity, it was thought desirable to try and reduce this uncertainty to not more than one mile per second. This is not only of scientific importance but would provide a method for the accurate and rapid determination of the distance between stations 50 to 100 miles apart, and should prove of value on trigonometric surveys. To this end, apparatus was installed on Mount Wilson and Mount San Antonia, which are 22 miles apart, for the purpose of measuring the time taken by light to travel this distance. Forest fires, and the consequent smoke and haze, prevented success during the summer of 1923, but very promising results have now been obtained. The results give 299,820 as the velocity of light in vacuo expressed in kilometres per second, which is believed to be true to within about one part in 10,000. It is proposed to repeat the experiment next summer with some refinements, by which it is hoped to obtain an accuracy to within about 2 parts in 100,000.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—A dull tone still prevails in the Scottish steel trade and prospects of any marked improvement in the industry seem remote. Buyers are very scarce and are not inclined for much dealing at present, being content, in most cases, only to fix up current requirements and leave the future to look after itself. The net result of this is that there is no regularity in the running of plant, and plates, in particular, are in very poor request. Sectional material is also very slow, and the day-to-day demand is far from heavy or at all satisfactory. In the black-sheet trade the booking of light sheets and galvanised sorts for export is again the turn better and order books generally are well filled for the next month or two. A slight improvement has taken place in the demand for the heavier gauges, but makers can undertake a great deal more business in this line without any great difficulty. Prices are steady, and although the following are the current quotations, buyers might be able to place orders of decent tonnage on slightly better terms: Boiler plates, 13*l.* per ton; ship plates, 9*l.* 15*s.* per ton; sections, 9*l.* 10*s.* per ton; and sheets, $\frac{1}{8}$ in. to $\frac{1}{4}$ in., 12*l.* per ton, all delivered Glasgow stations.

Malleable Iron Trade.—Conditions in the malleable iron trade of the West of Scotland have not changed and a very poor demand exists. Business of any kind is extremely difficult to secure and the outlook is very obscure. The price of "Crown" bars is still quoted at 12*l.* per ton, delivered at Glasgow stations. Re-rolled steel bars are dull.

Scottish Pig-Iron Trade.—In the pig-iron trade of Scotland the general tone is again a little better and consumers seem more inclined to deal. Some fair lots have been sold forward and current buying is a trifle more satisfactory. This has made no change in prices, however, owing to the heavy stocks on makers' hands, but as soon as these begin to disappear there is every prospect of prices hardening up a bit. The current quotations are as follow: Hematite, 4*l.* 15*s.* per ton, delivered at the steel works; foundry iron, No. 1, 4*l.* 15*s.* per ton, and No. 3, 4*l.* 10*s.* per ton, both on trucks at makers' yards.

Scottish Pig-Iron Shipments.—The shipment of Scottish pig-iron from Glasgow Harbour for the week ended last Saturday, November 22, amounted to 937 tons. Of that total, 760 tons went overseas and 177 tons went coastwise. For the corresponding week of last year the figures were: 513 tons foreign and 54 tons coastwise, making a total shipment of 567 tons.

Wages in the Iron Trade.—Messrs. James C. Bishop and Owen Coyle, joint secretaries of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board, have received the following intimation from Sir John M. MacLeod, C.A., Glasgow: "In terms of the remit I have examined the employers' books for September and October, 1924, and I certify that the average net selling price brought out is 12*l.* 11*s.* 10·3*d.*" This means that there will be no increase in the wages of the workmen.

Shipbuilding.—Messrs. Napier and Miller, Old Kilpatrick, are to build the hulls of the two ferry steamers for which Messrs. McKie and Baxter, engineers, Govan, received the contract referred to here last week. These vessels, which will be single-screw passenger and vehicular steamers 170 ft. in length, are to the order of the Levis Ferry Company, of Quebec. Messrs. McKie and Baxter will supply all the machinery. Messrs. Napier and Miller have also contracted to build another cargo vessel for the Clydesdale Navigation Company (Messrs. George Nisbet and Co.), Glasgow. This vessel will be similar to the Blairgowrie, which was launched in July for the same owners and will be 3,300 tons gross and of 5,800 tons d.w. carrying capacity. This order is now the fourth received this year from the same firm. Messrs. Ferguson Brothers (Port Glasgow), Limited, have contracted to build a self-propelling, twin-screw, grab hopper dredger of 1,100 tons carrying capacity for the Mersey Docks and Harbour Board. Messrs. David and William Henderson and Co., Limited, Partick, have received the contract to build two cargo steamers for North-East Coast owners.

THE DRIVING OF FRESHLY-MOULDED CONCRETE PILES.—By the courtesy of Messrs. Gunton and Gunton, architects, and Messrs. L. J. Speight, Limited, contractors, a party of engineers was given facilities on Monday last for witnessing the driving of piles of reinforced concrete only about 48 hours old, at the site of the new premises of the Westminster Bank in Cheapside, E.C. The piles in question were made with Ciment Fondu supplied by the Lafarge Aluminous Cement Company, Limited, of 296, High Holborn, W.C. The bank building will be a steel-framed structure on ferro-concrete pile foundations. The piles are 14 in. by 14 in. by 20 ft. 6 in. long, reinforced with four bars, one at each corner, with links closely spaced. The concrete proportions are 7 cwt. of cement, 13½ cub. ft. sand, and 27 cub. ft. aggregate, or approximately 1 : 1½ : 3. The piles were moulded on the site, two boxes only being employed, and the work taking up very little space on account of the short time elapsing between pouring and driving. The piles were driven with a 2½-ton tup falling 3 ft., and the final set required was 2¾ in. for 30 blows. The pile head was protected by a helmet, extending above which was a short length of timber which took the actual blow of the tup. The character of the ground was large and small gravel, and driving was found, in nearly all instances, to be very hard. The piles on which the demonstration was carried out suffered in no way from the effects of driving. The maximum load they are intended to carry is 68 tons.

NOTICES OF MEETINGS.

THE ROYAL METEOROLOGICAL SOCIETY.—To-night, at 5 p.m., at the Imperial College of Science and Technology, Imperial Institute-road, South Kensington, S.W.7. Joint Meeting with the Physical Society. Discussion on "Ionization in the Atmosphere; the Influence on the Propagation of Wireless Signals." (1) Opening Address by Dr. W. H. Eccles, F.R.S. (2) Atmospheric Ionization and its Variations," by Dr. C. Chree, F.R.S. (3) "Experimental Observations of the Strength of Wireless Signals as affected by the Path of the Signals, Time of Day and Season of Year," by Professor E. V. Appleton, M.A., D.Sc. (4) "Atmospherics," by Mr. R. A. Watson Watt. (5) "The Electric Field of a Thunderstorm and Some of its Effects," by Prof. C. T. R. Wilson, F.R.S. (6) "The Evidence of Terrestrial Magnetism for the Existence of Highly Ionized Regions in the Upper Atmosphere," by Professor S. Chapman, F.R.S.

THE JUNIOR INSTITUTION OF ENGINEERS.—To-night, at 6.30 p.m., at 39, Victoria-street, S.W.1. Exhibition of latest Scientific Instruments and Appliances for the Use of Engineers. Friday, December 5, at 7.30 p.m. Lecturette. "Metal Cutting under Water by the Oxy-Acetylene Blow Pipe," by Mr. J. B. Polland.

THE INSTITUTION OF MECHANICAL ENGINEERS.—To-night, at 7 p.m., at Storey's-gate, S.W.1. Informal Meeting. "Centrifugal and Rotary Pumps." Introduced by Mr. G. L. Ponsford. Friday, December 5, at 6 p.m., Extra General Meeting. "The Effects of Low and High Temperatures on Materials," by Professor F. C. Lea, D.Sc. "The Elastic Limit in Tension, its Influence on the Breakdown by Fatigue," by Mr. J. M. Lessells, B.Sc.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Monday, December 1, at 5 p.m., at 21, Albemarle-street, W.1. General Monthly Meeting.

THE NORTHAMPTON ENGINEERING COLLEGE ENGINEERING SOCIETY.—Monday, December 1, at 5.30 p.m., at St. John-street, E.C.1. "The Poulsen Arc," by Mr. E. E. Hutchings.

THE SOCIETY OF ENGINEERS (INCORPORATED). Monday, December 1, at 5.30 p.m., at the Geological Society, Burlington House, Piccadilly, W.1. "Recent Developments in Ferro-Concrete Cooling Towers," by Mr. H. A. Rickwood.

THE INSTITUTION OF ELECTRICAL ENGINEERS: WESTERN CENTRE.—Monday, December 1, at 6 p.m., at the South Wales Institute of Engineers, Park-place, Cardiff. "Automatic and Semi-Automatic Rectifier Substations." by Mr. G. Rogers.

THE JUNIOR INSTITUTION OF ENGINEERS: NORTH WESTERN SECTION.—Monday, December 1, at 7.30 p.m., at the Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester. Lecture: "Modern Locomotive Lubrication Practice," by Mr. B. Spencer.

THE INSTITUTION OF CIVIL ENGINEERS: NEWCASTLE UPON-TYNE ASSOCIATION. Monday, December 1, at 7.30 p.m., in the Lecture Hall of the Mining Institute, Neville Hall, Newcastle-on-Tyne. "Some Properties of Mild Steel with Special Reference to its Behaviour at High Temperatures," by Mr. E. Jule Rang, B.Sc.

THE BRADFORD ENGINEERING SOCIETY. Monday. December 1, at 7.30 p.m., at the Bedford Technical College. Lecture, "The Gyro Compass," by Mr. R. B. Pullin.

THE INSTITUTION OF RUBBER INDUSTRY.—Monday, December 1, at 8 p.m., at the Engineer's Club, Coventry-street, W.1. "Research Work on the Plantation," by Major B. J. Eaton, F.I.C.

THE ROYAL SOCIETY OF ARTS. Monday, December 1, at 8 p.m., at John-street, Adelphi, W.C.2. Cantor Lecture. "Modern Colour Problems" (Lecture II), by Mr. Louis C. Martin, D.I.C., D.Sc. Wednesday, December 3, at 8 p.m. Ordinary Meeting. "The Teaching of Science in Secondary Schools," by Prof. C. A. Carus-Wilson, M.A., F.R.G.S. Friday, December 5, at 4.30 p.m. Indian Section. "Problems of Food, with Special Reference to India," by Lieut.-Colonel R. McCarrison, C.I.E., M.D., LL.D., D.Sc.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Tuesday, December 2, at 5.30 p.m., at the Royal Society of Arts, John-street, Adelphi, W.C.2. "Fuel Oil Resources of the Future," by Mr. A. W. Nash, B.Sc., M.I.Mech.E., and Mr. H. G. Shatwell, B.Sc., M.Sc. "The Somerset Oil Shales," by Mr. H. G. Shatwell, B.Sc., M.Sc., and Mr. A. W. Nash, B.Sc., M.I.Mech. E.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 2, at 6 p.m., at Great George-street, S.W.1. Ordinary Meeting. Paper to be submitted for discussion: "Water-Supplies to the Smaller Provincial Towns of Egypt," by Messrs. Reginald Humphrey Lee Pennell and Herbert Addison.

THE INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—Tuesday, December 2, at 7 p.m., at the Chamber of Commerce, New-street. "Metal Spraying," by Mr. W. E. Ballard.

THE INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—Tuesday, December 2, at 7.30 p.m., in the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. "Aluminium, its Production and Uses," by Mr. G. B. Brook, F.I.C.

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Tuesday, December 2, at 7.30 p.m., in the Rankine Hall, 39, Elmbank-crescent, Glasgow. "The Further Development of Large Power Diesel Engines," by Mr. W. D. McLaren.

THE WEST YORKSHIRE METALLURGICAL SOCIETY.—Tuesday, December 2, at 7.30 p.m., at the George Hotel, Huddersfield. Discussion on "The Corrosion of Engineering Materials."

THE INSTITUTION OF ELECTRICAL ENGINEERS: WIRELESS SECTION.—Wednesday, December 3, at 6 p.m., at Savoy-place, Victoria-embankment, W.C.2. "Wireless Telegraph Valve Transmitters employing Rectified Alternating Current," by Mr. G. Shearing.

THE INSTITUTION OF SANITARY ENGINEERS.—Wednesday, December 3, at 7.30 p.m., at Caxton Hall, Westminster, S.W.1. "House Drainage, with Special Reference to the Intercepting Trap," by Mr. H. Alfred Roechling, M.Inst.C.E.

THE LIVERPOOL ENGINEERING SOCIETY.—Wednesday, December 3, at 8 p.m., at the Society's Rooms, The Temple, Dale-street, Liverpool. "Sulphuric Acid," by Mr. C. S. Imison.

THE INSTITUTION OF WATER ENGINEERS.—Thursday, December 4, at 10.30 a.m., at the Geological Society, Burlington House, Piccadilly, W.1. "Iron Deposit in Cast Iron Pipes," by Mr. J. R. Fox, M.Inst.C.E. "Fluctuations of Annual Rainfall: Three Driest Consecutive Years," by Mr. John Glasspoole, M.Sc. "The Biology of Jersey Waterworks," by Mr. W. Rushton, D.Sc., with an Addendum by Mr. A. J. Jenkins. "On the Preparation of a Rainfall Map of the British Isles," by the late M. de Carle S. Salter.

THE INSTITUTION OF ELECTRICAL ENGINEERS. Thursday, December 4, at 6 p.m., at Savoy place, Victoria Embankment, W.C. 2. Lecture. "Gyroscopic Pendulums," by Prof. J. G. Gray, D.Sc., and Mr. J. Gray.

THE INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Thursday, December 4, at 7.30 p.m., in the Mappin Hall, The University, St. George's-square. Conjoint Meeting with Silver Trades Society. Discussion on "Electro-Plating," opened by Mr. A. Jefferson.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—Though belated, the statement of the Mines Department showing the working of the coal industry in the quarter ended March last, is of considerable interest. It is shown that in South Wales 12,444,480 tons of coal were raised, of which 11,357,895 tons were commercially disposable. The cost of production amounted to 11,303,551*l.*, and the revenue secured from sales to 12,430,106*l.*, leaving a profit of 1,241,631*l.*, or 2*s.* 2·24*d.* per ton. The cost of production amounted to 19*s.* 8·42*d.* per ton and the revenue to 21*s.* 10·66*d.* per ton. Of the cost of production, wages amounted to 13*s.* 2·59*d.* per ton, stores and timber to 2*s.* 9·85*d.*, and other costs to 3*s.* 0·49*d.* per ton. The number of workpeople employed was 225,464 and 15,377,131 man-shifts were worked, while 1,336,438 man-shifts which could have been worked were lost. The output per man shift in the quarter was 16·19 cwts. and the earnings per man-shift worked were 9*s.* 9·14*d.* The coal market has developed a stronger tone during the past week. A fair quantity of shipping has reached dock and this has put collieries in a more comfortable position. Some qualities are, in fact, in short supply, especially washed duffs, which are in good demand for coking purposes. Bituminous washed duff has, in fact, realised up to 19*s.* 6*d.*, while the best steam smalls, too, are in good demand round 16*s.* 6*d.* Sized coals are in limited supply and the best dry nuts command up to 32*s.* Best Admiralty large coal is steady at 27*s.* to 27*s.* 6*d.*, and seconds rule from 24*s.* 6*d.* to 25*s.* 6*d.*, but Monmouthshires are still in excessive supply at 23*s.* 6*d.* to 24*s.* A considerable number of collieries are, however, still closed down, and stoppages are experienced at those working, but not to the same extent as was the case a few weeks ago. According to a statement just issued by the Great Western Railway Company, who control all the docks in South Wales, shipments of coal, coke and patent fuel from the six ports in the ten months ended November 2 amounted to 27,019,425 tons, compared with 31,009,115 tons in the corresponding period of last year, a reduction of 3,989,690 tons. All the ports shared in this decline, exports from Cardiff dropping from 7,498,736 tons to 6,851,559 tons, at Swansea from 3,718,810 tons to 3,261,364 tons, at Newport from 5,797,095 tons to 4,793,171 tons, at Barry from 8,696,082 tons to 7,639,628 tons, at Port Talbot from 2,369,265 tons to 1,935,449 tons and at Penarth from 2,929,127 tons to 2,538,254 tons. The French State Railways are inviting prices for supplies over the first three or six months of next year. No quantities are mentioned, but merchants are invited to make offers for definite quantities over the alternative periods.

Iron and Steel Trades.—Because of a scarcity of prompt business, a number of Welsh tinplate mills have been closed down temporarily. Exports of iron and steel goods in the past week amounted to 18,077 tons, compared with only 9,574 tons in the previous week. Shipments of tinplates and terneplates totalled 9,600 tons against 6,669 tons, blackplates and sheets to 6,799 tons against 918 tons, galvanised sheets to 1,060 tons against 1,467 tons, and other iron and steel goods to 618 tons against 520 tons.

THE ROYAL SANITARY INSTITUTE.—The next Congress and Health Exhibition of The Royal Sanitary Institute will be held at Edinburgh from July 20 to 25, 1925, by invitation of the Magistrates and City Council.

THE PENANG HILLS RAILWAY.

CONSTRUCTED BY THE FEDERATED MALAY STATES RAILWAYS; MR. A. R. JOHNSON, A.M.I.MECH.E., ENGINEER.

(*For Description, see Page* 726.)

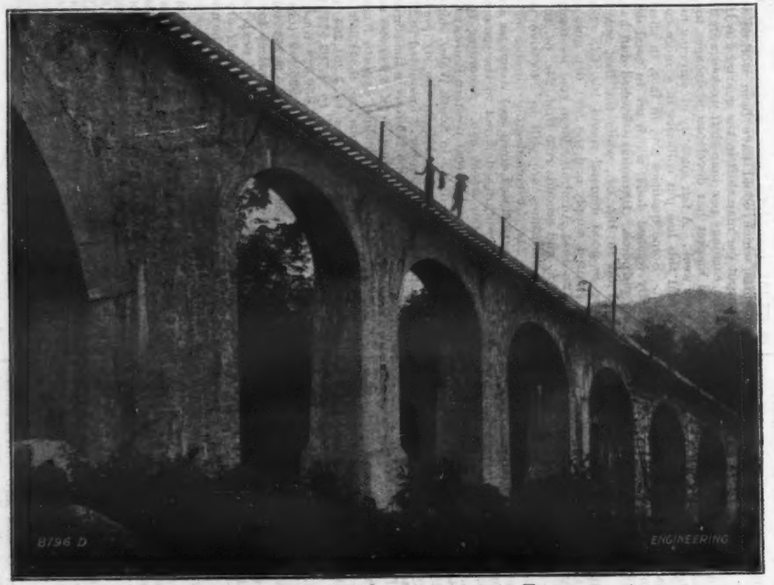


FIG. 62. VIEW OF VIADUCT SHOWING FOOTWAY.

FIG. 63. VIADUCT AND PASSING PLACE; UPPER SECTION.

FIG. 64. TRACK SHOWING PASSING PLACE AND INCLINED GUIDE PULLEYS.

FIG. 65. TRACK SHOWING FOOTWAY AND STRAIGHT GUIDE PULLEYS.

FIG. 64. TRACK SHOWING PASSING PLACE AND INCLINED GUIDE PULLEYS.

FIG. 65. TRACK SHOWING FOOTWAY AND STRAIGHT GUIDE PULLEYS.

JAPANESE TRAIN-FERRY TURBINE STEAMER "SHOHU MARU."

CONSTRUCTED BY THE URAGA DOCK COMPANY, URAGA, JAPAN.

(For Description, see Page 735.)

Fig. 1. PROFILE.

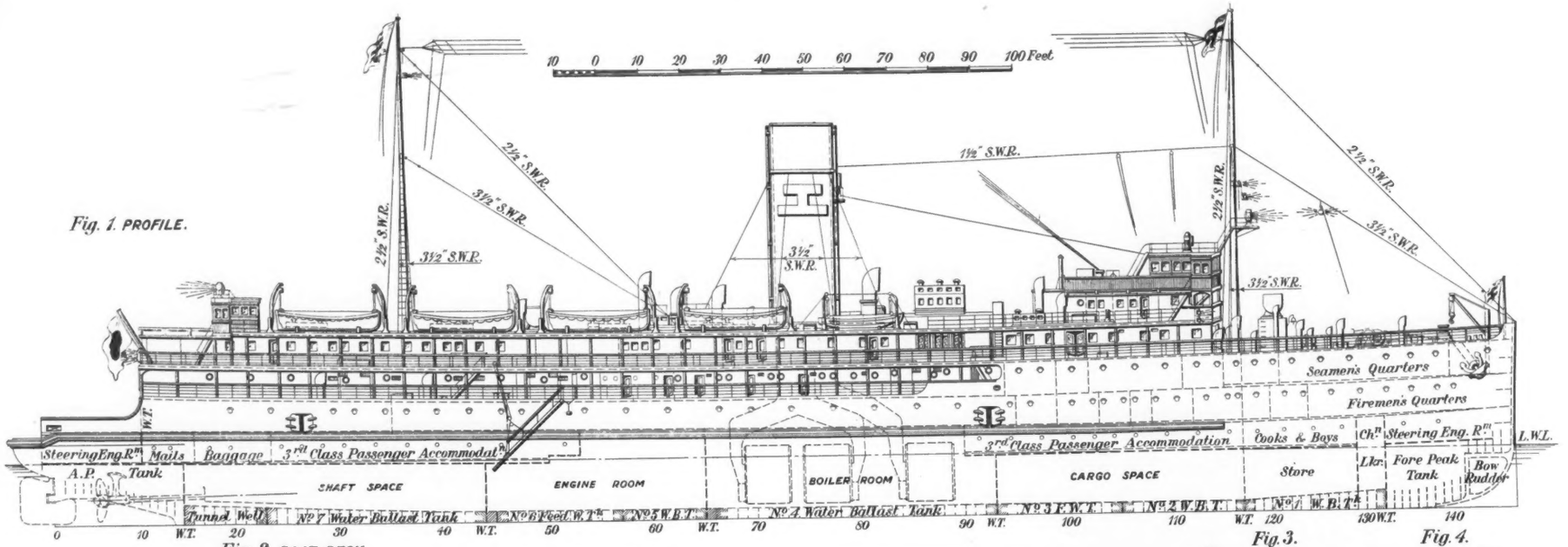


Fig. 2. BOAT DECK.

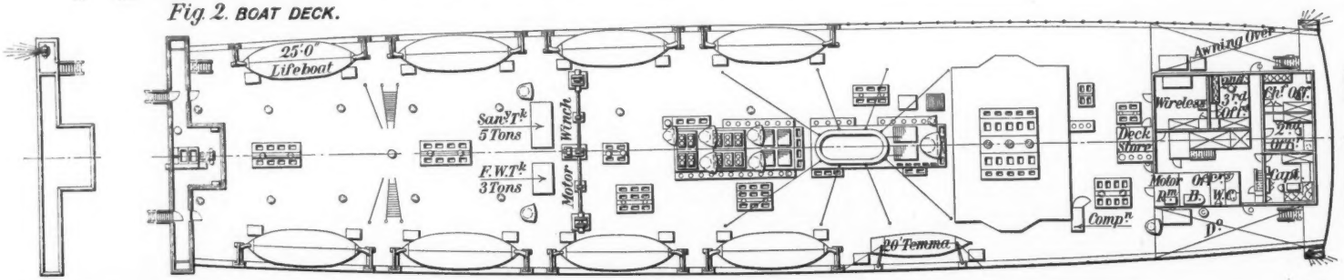


Fig. 3. NAV.N BRIDGE.

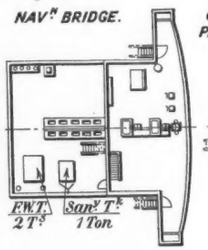


Fig. 4. COMPASS PLATFORM.

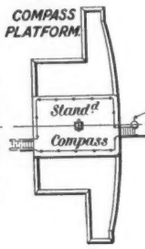


Fig. 5. UPPER PROMENADE DECK.

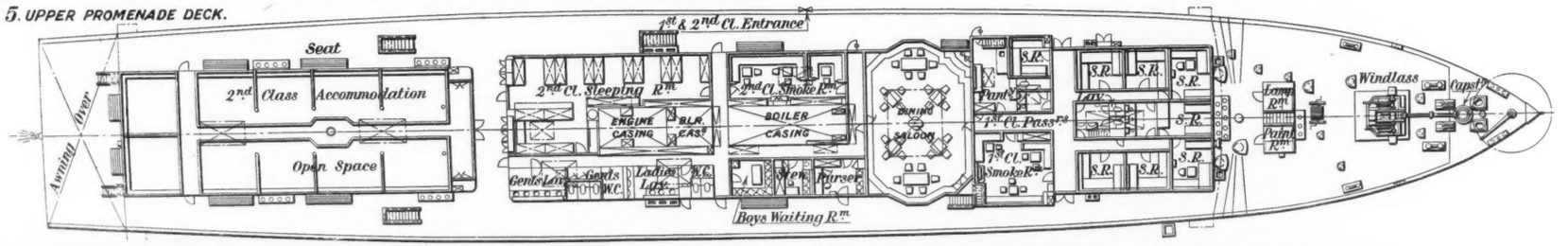


Fig. 6. LOWER PROMENADE DECK.

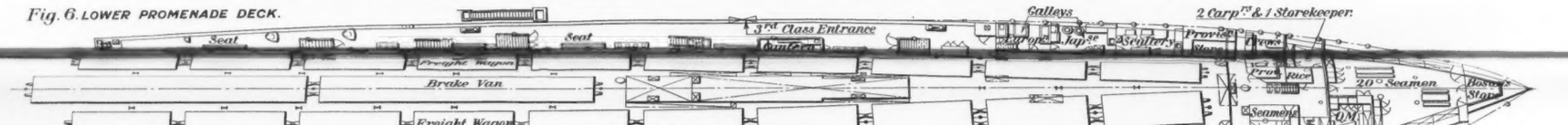


Fig. 6. LOWER PROMENADE DECK.

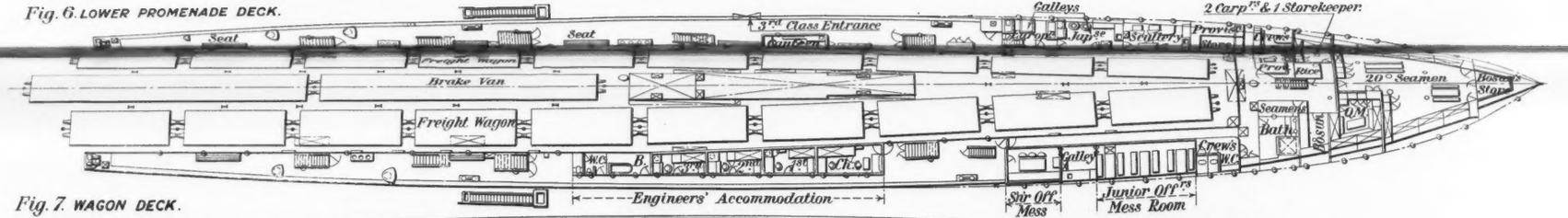


Fig. 7. WAGON DECK.

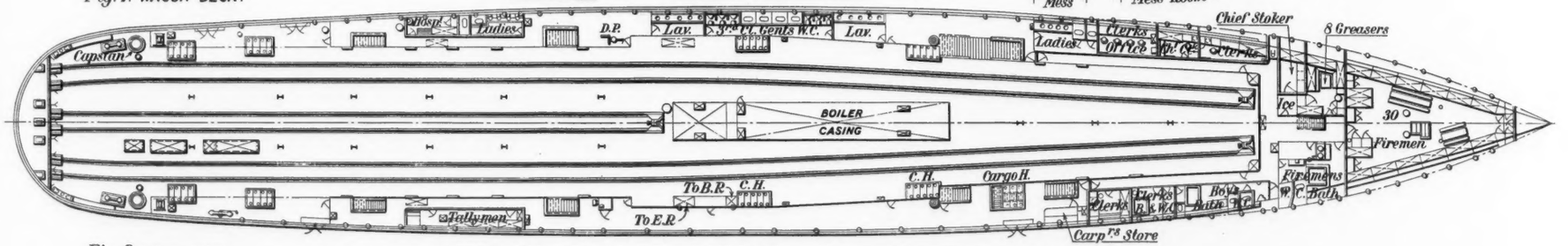
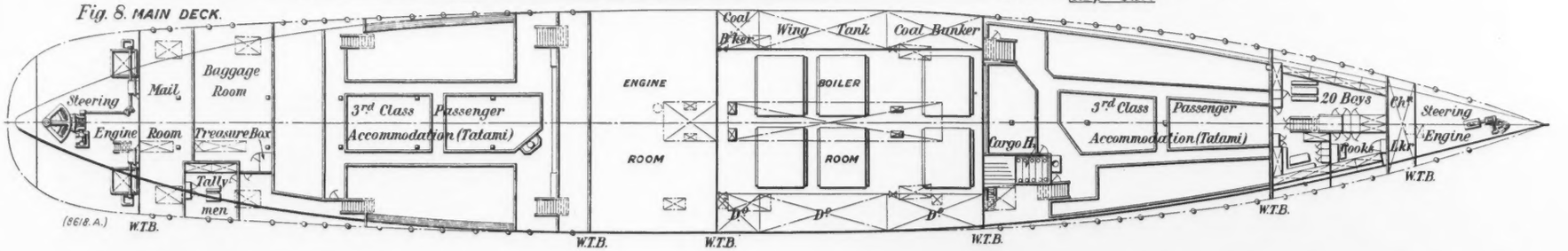


Fig. 8. MAIN DECK.



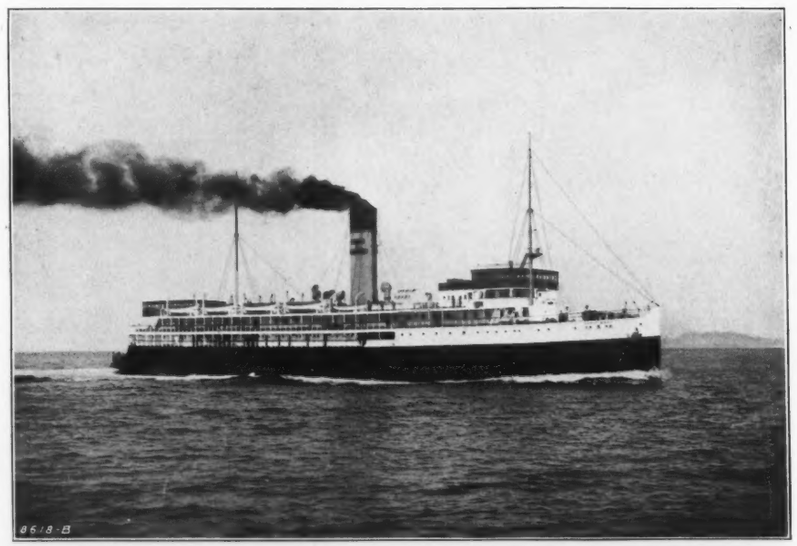


FIG. 9. GENERAL VIEW OF VESSEL.

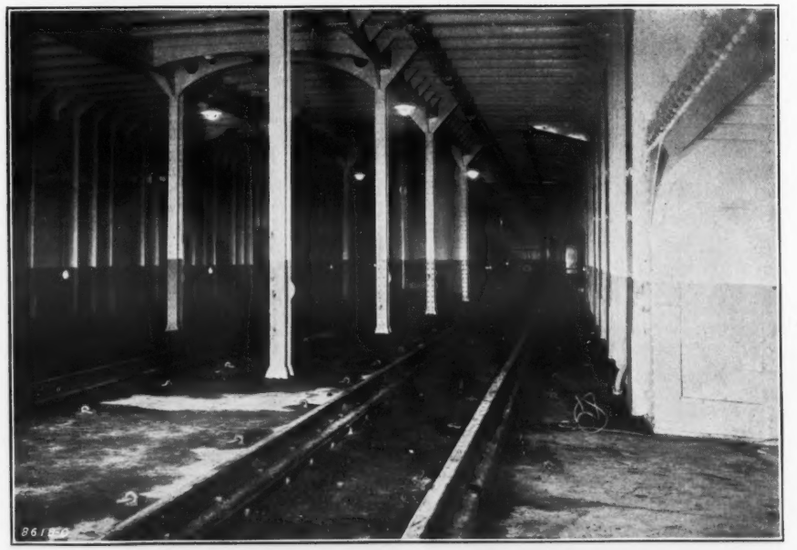


FIG. 10. THE WAGON DECK.

ENGINEERING.

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Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity of going to press early with a portion of the edition, alterations for standing advertisements should be received 10 days previous to the day of publication.

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UNITED STATES: For Subscription, New York: W. H. Wiley, 440, Fourth Avenue. For Advertisements: J. S. Allan, 30, Church Street, New York.

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Two-Page Plate.—JAPANESE TRAIN-FERRY TURBINE STEAMER "SHOHU MARU."

ENGINEERING.

FRIDAY, NOVEMBER 28, 1924.

THE WHITWORTH SCHOLARSHIPS.

EVER since the Whitworth Scholarships were founded they have been regarded as the chief prizes obtainable by young men in course of training as engineers. They are not sought on account of their money value alone, though this is considerable, but because the distinction of being a Whitworth Scholar is a very useful commercial asset in the opening stages of an engineering career. There is, moreover, the personal gratification of publicly excelling in a competition which is freely open to properly qualified candidates from all parts of the British Empire. From the engineering point of view the Whitworth Scholarhips are much more important than university degrees in engineering, for the latter, besides being non-competitive, are obtainable by students who have never seen the inside of a factory. It has always been a condition of the scholarships that candidates should have previously obtained a considerable amount of practical experience in an engineering works, and there can be no doubt that Sir Joseph Whitworth's idea in founding them was to enable the ambitious working apprentice to pursue the study of the principles of engineering under conditions which, without the scholarships, he could not afford. Sir Joseph, who was a self-taught mechanic himself, had no illusions as to what engineering really is, namely, a practical constructive art, involving considerations so complex that no theory can adequately take them all into account. His encouragement of theoretical knowledge showed that he appreciated its value, but he wished it to be erected on a foundation of thorough practical experience of the materials and processes to which the knowledge referred, so that every deduction from theory could be checked by a sound judgment.

The Board of Education, who administer the scholarships, have very properly endeavoured to carry out the intentions of Sir Joseph Whitworth by maintaining the special features which distinguish the scholarships from mere academic awards. Not only is it right that the wishes of the "pious founder" should be respected, but it is perhaps even more important that the one public competition for success in which a candidate must have practical engineering qualifications should retain the characteristic which gives success its prestige. The more jealously the basis of the Whitworth Scholarship is guarded and the more closely the awards are scrutinised the better, and for this reason we are glad to publish the letter which appears on this subject on another page. Our correspondent, Mr. Ottewell, himself a Whitworth Scholar, points out what is, on the face of it, a very remarkable fact concerning the geographical distribution of the latest awards. There were in all 33 successful candidates this year, 2 obtaining the Senior Scholarships of 500*l.* each, 6 obtaining the ordinary scholarships of 375*l.*, and 25 getting prizes of 10*l.* each. As will be seen from our correspondent's letter, no less than 26 of the 33 awards granted this year have gone to students from three Royal Dockyards in the South of England, another three went to students from Woolwich Arsenal, and one to a Pembroke Dockyard student, making, in all, a total of 30 awards out of 33 to Government establishments. Of the remaining three, two, it is curious to note, went to Sunderland and Hartlepool, both shipbuilding towns, and only one to an inland centre, namely, Crewe.

The extraordinary nature of this result will be evident from a calculation of its probability. If we assume that the dockyards and arsenals between them contain as many as one fiftieth of the whole of the apprentices in the country, the probability of thirty out of thirty three awards going to apprentices in these establishments is less than one in 18×10^{46}, or in other words the event would normally occur less than once in a billion years. There is clearly some strong reason why the dockyard boys should be represented in the prize list in numbers altogether out of proportion to their numerical strength. The first thought which strikes one, namely, that the examination questions must unintentionally have been so framed as to give an unfair advantage to dockyard-trained students, is quite untenable. By the courtesy of the Board of Education, we have been furnished with copies of the papers set, and we failed to find a single question that deserved the slightest criticism on the grounds indicated. Furthermore, as all candidates, except the few who enter for the Senior Scholarships, are examined on exactly the same papers as are set for all the Royal Scholarhips, the fairness of the questions to all candidates is out of the question. It should be needless to add that the examiners do not know the name, the antecedents, or the occupation of any candidate whose work comes before them.

It will be remembered that the regulations for the Whitworth Scholarships were revised recently, the awards last year being the first under the new syllabus, but such changes as were made cannot in any way be held accountable for the preponderance of successes amongst Docykard-trained youths. We have examined the lists of successful candidates for several years past, and the same tale is consistently told. As long ago as 1913, out of the 24 awards then made, 9 went to candidates from Portsmouth Dockyard, and 8 more to candidates from other Government establishments at Woolwich, Devonport, Chatham and Enfield, only 7 being obtained by students from any of the civilian centres of engineering. Year after year we find a similar state of affairs, so that the question to which Mr. Ottewell calls attention is not new. We believe that the tide of successful Government-trained candidates set in about a quarter of a century ago. It should perhaps be regarded more from the converse point of view, namely, that from this time the candidates from the ordinary engineering centres failed to attain the standard of education which the scholarships require. Not that they did not have the mathematical or scientific knowledge to cope successfully with the papers set, but because fewer and fewer had the necessary minimum of shop experience behind it.

The subsequent careers of men who have gained Whitworth Scholarships is quite sufficient evidence that the conditions of Sir Joseph Whitworth's bequest are excellently adapted to produce engineers of the very best type. The system of Dockyard

training evidently produces such men, but we should not have to rely solely on our Government establishments for developing them. The native ability of the young men in the great engineering centres of the country must be at least equal to that of the Dockyard apprentices, and in aggregate amount, overwhelmingly greater. Yet the great prizes for young engineers go year after year to the Dockyards, as we have mentioned. The severe weeding out of students whose lack of ability or energy would handicap the progress of the others, which is one of the wisest features of Dockyard training, the traditions of study which have grown up in the yards and the excellence of the teaching provided are all factors in the case. The theoretical training is taken simultaneously with the practical work, the Authorities allowing several hours a week for classes. The result is certainly good, and there is no doubt the Dockyard system deserves the credit which the Scholarship awards for some years past reflect upon it.

The whole question is one which deserves the most careful consideration of engineering employers. The Dockyards cannot possibly turn out more than a minute fraction of the men needed to maintain and advance the engineering industry of this country, and even if they could, the men would be better still were they trained under commercial conditions of manufacturing. Furthermore, the practical experience available in a Dockyard does not cover more than a very small proportion of the kind of work an engineer has to do, so that, did each branch of the industry produce its own men, they would start with a knowledge of particular lines of manufacture which would be most valuable. If employers want good men, they must take them into their shops at the right age, train them themselves and give them every encouragement and facility for acquiring technical knowledge as the Dockyards do. It is no good leaving engineering education to universities and then grumbling because the result is not satisfactory. As employers are, after all, the final judges of the kind of youths they want, they should see to it that a suitable training is available for the rising generation. There is surely something wrong with engineering education when so many firms appear to find it necessary to employ foreign designers, or to purchase foreign designs for quite ordinary productions. If the engineering industry of this country is to retain the prestige which it has held in the past, it must so develop its native talent that we keep the lead in design and construction, instead of being content to follow, and this question turns almost entirely upon the training of our youths.

SKIN FRICTION IN AERONAUTICS.

The results of mathematical investigations of the theory of skin friction as applied to aerodynamical problems were given in an important paper on the subject read by Professor L. Bairstow at the Royal Aeronautical Society on Thursday, the 13th instant. Professor Bairstow first dealt with the hydrodynamics of lubrication, starting with the general equations of motion in two dimensions of an incompressible fluid, and mentioning the various modifications made to render the equations amenable to treatment. He then went on to explain that the essential differences between the aeronautical problem and that of lubrication arose from the absence in the former of a second solid surface enclosing the fluid. There was no obvious limit to the thickness of the fluid affected by the motion, say, of a flat plate moving in its own plane, although there was experimental justification for assuming the effective thickness to be small. Prandtl, in his boundary-layer theory, retained all the terms of steady motion in the equations and had considered the consequences of assuming the existence of a skin, this hypothesis, as in Reynold's theory, leading to the result that the velocities across the skin were small in comparison with those along it. The boundary layer, it may here be explained, is that in which the flow is viscous, the flow breaking down at the outer surface of the layer and being regarded as inviscid beyond it.

Professor Bairstow deduced the fundamental equations for the boundary-layer theory and pointed out that those for the theory of lubrication constituted a special case of the former. He stated, moreover, that the pressure through the boundary layer was sensibly constant and that outside of the boundary layer, where Bernouilli's theorem was presumed to hold, the pressure would be that measured at the surface of the solid. The velocity a little distance away from the surface, he said, could be deduced from the equation $p + \frac{1}{2}\rho q^2 = a$ constant, p being the observed surface pressure distribution and q the velocity of the fluid at the point considered. This had been shown to be practically true for an aerofoil by experiments carried out at the National Physical Laboratory, where observations of pressure distribution were made and compared with independent measurements of the air velocity at all points of the field except the boundary layer; no difficulty was experienced in estimating the velocity except in the immediate neighbourhood of the trailing edge.

An attempt was being made at the Imperial College to solve the fundamental equations from the data obtained from the National Physical Laboratory experiments, and the skin friction over the leading portion of the upper surface had already been calculated; it appeared, the author stated, that the thickness of the boundary layer there varied from 0·001 to 0·003 of the chord length. There were, however, already signs of complication due to the development of the wake, which made it appear possible that some of the assumptions of the boundary-layer theory would not hold near the trailing edge, although no special difficulty was anticipated in the calculations for the under surface.

A solution of the fundamental boundary-layer equations, the author stated, had been obtained by Blasius for a flat plate, using the hypothesis that when a plate in a fluid is moving along its plane, the rate of change of pressure along the surface is small enough to be negligible. With this assumption he found that the partial differential equations could be reduced to a single total differential equation. Following the general treatment of Blasius, with some modifications in detail which render practicable the extension of the theory to an aerofoil, Professor Bairstow obtained the value of the drag coefficient for a flat plate as $K_D = 1{\cdot}34\sqrt{\frac{\nu}{\bar{q}b}}$, where ν is the kinematic viscosity, $\bar{q}$ is the velocity outside the boundary layer, and b is the breadth of the plate in the direction of the stream. The drag coefficient is thus a function of a Reynold's number $\left(\frac{\bar{q}b}{\nu}\right)$ and decreases as the velocity decreases.

To compare the theoretical results with those obtained by experiment, Professor Bairstow took the observations of Burgess and Zijnan made at the aerodynamic laboratory at Delft on a glass plate having a rounded leading edge. In these experiments the velocity of air in the boundary layer was measured by hot-wire anemometers using platinum wires only 0·005 cm. in diameter. The observations obtained in these experiments, plotted with the curve calculated by Blasius, showed the difference to increase with the distance from the leading edge, but, at the same time, served to indicate that the formula was a good first approximation to the actual observations, at least as far as the front part of the plate was concerned. The differences which occurred at the rear part of the plate were attributed by Burgess to turbulence.

In some other respects the agreement between theory and experiment is not exact, and Professor Bairstow remarked that the boundary-layer theory may ultimately prove to be but a poor approximation to the truth. He pointed out, however, that the experiments on the glass plate did not represent the two-dimensional motion assumed in the calculations, that the effect of the rounded edge might not be unimportant, and that errors due to the lateral spreading of the air might be expected to increase with the distance from the leading edge. Other defects, he mentioned, were that the motion might be turbulent and the difficulties of a fluctuating motion might be formidable; the loss of pressure along the plate was ignored in the calculations; and the Prandtl equations were mathematical approximations. Most of the defects, however would probably be removed at an early date.

In conclusion, Professor Bairstow expressed the view that while the form of enquiry outlined should be continued it could not be regarded as satisfactory as at present derived. The study of aerodynamics as a form of fluid motion, however, had now received international recognition, and progress was assured as a result of the primary interest of a number of individuals in the subject.

The reading of the paper was followed by a lengthy discussion in the course of which Major A. R. Low stated that Lanchester, before any of the German investigators had entered the field, had deduced a formula for skin friction identical in form with that given by the author and differing only in the value of the numerical coefficients. He also made a long statement of the conditions of instability of viscous flow and gave references to problems which had been already solved by Bénard, Rayleigh and Taylor. Dr. T. E. Stanton mentioned that the theory given in the paper was in good agreement with the results of experiments made on flat plates at the National Physical Laboratory, and Dr. H. Levy called attention to the fact that although the curvature of the surface had been neglected in the theory, the experimental results were in better agreement near the leading edge where the surface was curved, than they were farther back where the surface was flat. Dr. N. A. V. Piercy agreed as to the importance of a criterion of instability and Mr. R. V. Southwell, in the course of his remarks on the paper, expressed regret that we, in this country, had been so long in realising the value of theoretical investigations in aerodynamics that the Continental workers had been able to get ahead of us on this side of this subject. Professor Bairstow, who replied briefly owing to the lateness of the hour, differed from Major Low as to the identity of the results of Lanchester and Blasius, but agreed with Dr. Levy that there was a difficulty with regard to the leading edge. He intended to reply more fully in writing to the various points raised in the discussion.

RECENT DEVELOPMENTS IN REFRIGERATION RESEARCH.

At a meeting of the British Cold Storage and Ice Association, held on November 17 in the rooms of the Royal Society of Arts, Adelphi, Dr. Ezer Griffiths, of the National Physical Laboratory, read a paper describing some recent experimental work on refrigeration. At the National Physical Laboratory, comprehensive and accurate tests of the insulating properties of different materials had, he said, been made, using the apparatus represented in Fig. 1. The material to be tested was formed into slabs, which were arranged sandwich fashion on opposite sides of a "hot plate," which consisted of two plates of aluminium surrounded by a guard ring to prevent side leakage of the heat. This hot plate was heated electrically, and thermocouples were provided which indicated the temperature at a number of points. To the outer faces of the slabs under test were applied two cold plates, which were maintained at a constant temperature by water circulated through the plates by the pump shown. The temperature of this water was maintained constant by a sensitive thermostat, and means were also provided for measuring the temperature at different points of the cold plates by copper-constantan couples. Other couples were used to measure the temperature of the actual faces of the slabs under test. These were of the flat disc type, and were insulated from the hot and cold plates by a single layer of blotting paper. A very high degree of uniformity of temperature was attained as indicated in Fig. 2, where the figures represent the temperatures observed at different points.

For large-scale experiments on slabs up to 4 ft. square, and up to 6 in. thick, the apparatus represented in Fig. 3 was used. In principle this was identical with that already described, but the cold plates were cooled by brine circulation through a grid of iron pipes attached to the back faces of two steel plates. This apparatus was also used for testing the

insulating properties of slag wool, granulated cork, charcoal and similar materials. The conductivity of these was largely dependent upon the closeness of the packing, since if packed so lightly that convection currents were established in the entrapped air, the resistance to heat flow was reduced, and moreover the conductivity was no longer independent of the dimensions of the slabs. This was well shown in Fig. 4, where the conductivity of slag wool was plotted against the density of packing, using slabs 12 in., 26 in. and 60 in. square. It would be seen that down to density of about 12 lb. per square foot the conductivity was the same for all sizes, but at this limit the 60-in. slabs began to show a higher conductivity than the smaller ones, which increased as the density of the packing was still further reduced, and a little later on similar divergences were shown by the smaller slabs. The dotted curve shown at the top right-hand corner of the diagram was obtained with a material which had been specially prepared so as to be as inefficient as possible. The straight part of this curve was nearly co-linear with the full line curve, but the breakaway due to convection currents occurred when the density of packing was about 21½ lb. per cub. ft.

The ideal material for cold storage insulation would, the speaker continued, be an assemblage of minute cells, containing air enclosed in a light framework impervious to moisture. It was sometimes observed, however, that fibrous or granular insulating materials, such as slag wool or granulated cork, froze up into a solid block, and water had about ten times the conductivity of the dry insulating materials. Inspection of the woodwork facing the material might show it to be perfectly sound, and the question arose as to how the moisture had got into the insulation. It appeared that one way was by the diffusion of moist air into the interstices, in which case the moisture was frozen out near the cold face. In one experiment made to elucidate this, a slab of slag wool had one face kept at 15 deg. C., and the other at room temperature. Periodical weighings showed that in 26 hours the weight had increased by 1·9 per cent., due to the condensation of the moisture.

The result, thus obtained in a few hours might require years if the faces were securely boarded in, but in practice it was impossible to seal off the material perfectly. There was always some breathing due either to alterations of the barometric pressure, or to the practice of reducing the temperature of a cold store during the day, so as to avoid the necessity for keeping machinery running at night. It was important, therefore, that the surface of an insulator should be coated with a substance of low permeability. It was, accordingly, decided to measure at the National Physical Laboratory, the rate of diffusion of gases through various materials.

The apparatus is represented in Fig. 5, where B denotes the material under examination, which was fixed in a metal case A. The cover C was used for experiments with other gases than air, and for the purpose of testing the tightness of the wax seal. The manometers E and D served for measuring the pressure difference between the two faces of the slab. The ballonets H served to steady the gas supply.

The author said that not many reliable experiments on the component parts of refrigerators had been made in this country, but that a good deal was being done in America. The York Manufacturing Company had equipped a laboratory for this purpose, at a cost of 15,000*l.* for plant alone, and the weekly pay roll averaged 130*l.* Here different types of compressor had been tested, and much information had also been obtained as to the effect of air leakage on the efficiency of the ammonia condensers. In these it was often found that the temperature in the condenser was sometimes as much as 10 degrees Fahrenheit lower than that corresponding to the pressure.

Dr. Griffiths next dealt with investigations carried out by his brother on behalf of the Union of South Africa, in connection with the transport of fruit both by rail and by ocean. Some of the fruit had to be carried by rail for four or five days before reaching the point of shipment. The investigations made showed that, even when iced *en route*, the refrigerated fruit trucks sometimes reached their destination with portions of their consignment at a temperature of 100 deg. F. Other observations made on these trucks showed that the temperature might differ by 12 deg. F. at different points. Smoke observations showed that with any practical type of truck having end bunkers for the ice there were regions inside where the air was stagnant. As the result of these observations an experimental truck had been designed, in which the ice tank covered almost the whole of the roof. With this truck the coolest part of the interior was at the top, and the temperature did not differ by more than 3 deg. F. at different points, whilst the average temperature was 4 deg. to 5 deg. lower than with end-bunker trucks. Comparative records taken with the different types of truck are reproduced in Fig. 6. South African experience showed the advisability of pre-cooling the fruit before it was placed on ship board.

The author said that he had also taken part in the investigations made into the conditions of the refrigerated chambers on the service between Australia and the United Kingdom. Four ships, representing different systems of refrigeration, were equipped with temperature-measuring and gas-analysis instruments, and a fifth ship with an automatic carbon dioxide and oxygen recorder only. The electrical resistance thermometer used was

Fig. 1.

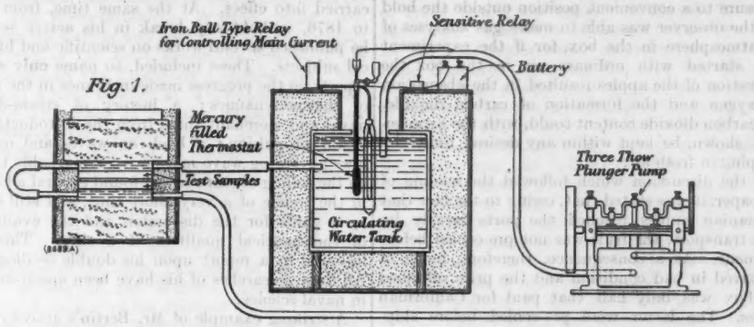


Fig. 2.

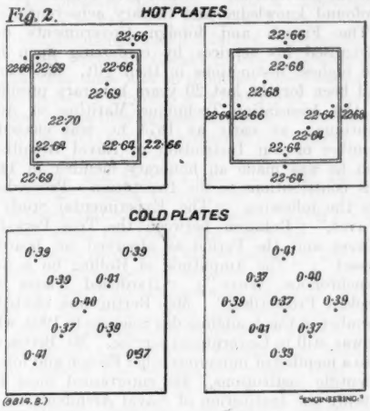


Fig. 3.

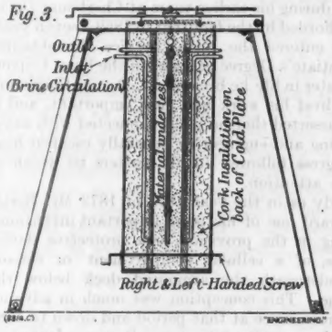


Fig. 4. VARIATION OF THERMAL CONDUCTIVITY WITH DENSITY OF PACKING.

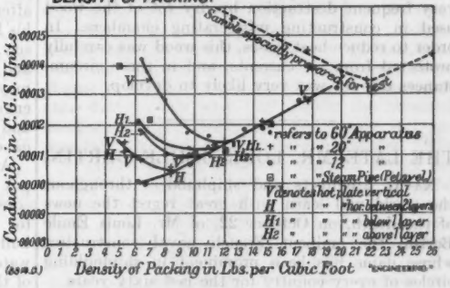

Conductivity in C.G.S. Units
Density of Packing in Lbs. per Cubic Foot
refers to 60" Apparatus
V denotes hot plate vertical
H " " horizontal

Fig. 5.

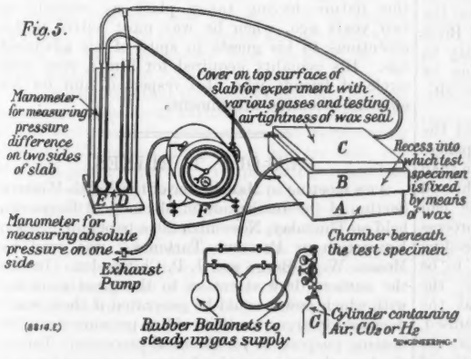

Manometer for measuring pressure difference on two sides of slab
Cover on top surface of slab for experiment with various gases and testing airtightness of wax seal
Recess into which test specimen is fixed by means of wax
Chamber beneath the test specimen
Manometer for measuring absolute pressure on one side
Exhaust Pump
Rubber Ballonets to steady up gas supply
Cylinder containing Air, CO2 or He

Fig. 6.

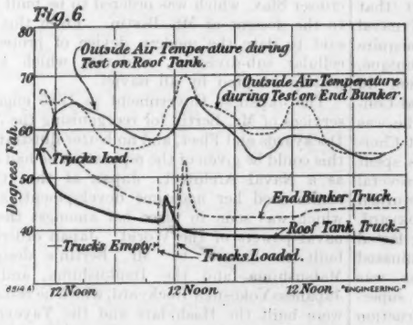
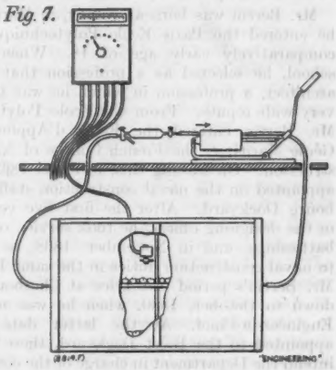


Fig. 7.



placed inside the actual fruit boxes. The general arrangement of the plant used is represented diagrammatically in Fig. 7. The large box, constituting an airtight enclosure for four boxes of apples, was taken down into the hold, the apple boxes, selected at random from the cargo, being loaded and the lid sealed down. The enclosure was then built into the bulk of the cargo so as to be subjected to precisely the same conditions as regards temperature. Pipes led away from the enclosure to a convenient position outside the hold and the observer was able to make gas analyses of the atmosphere in the box, for if the experiment were started with ordinary air in the box the respiration of the apples resulted in the absorption of oxygen and the formation of carbon dioxide. The carbon dioxide content could, with the arrangement shown, be kept within any desired limits by pumping in fresh air.

In the discussion which followed the reading of the paper, it was stated that, owing to the fact that Tasmanian apples reached the ports largely by river transport, the fruit was not pre-cooled before shipment. As a consequence, therefore, much of it arrived in bad condition and the price obtained per box was only half that paid for Californian apples. The latter were pre-cooled before shipment, as also were most of the apples shipped from Australia. Several speakers also referred to the very frequent destruction by dry rot of the wood used in constructing refrigerating chambers. In order to reduce heat losses, this wood was carefully protected from air currents, and in these circumstances dry rot was very likely to develop.

THE LATE MR. LOUIS EMILE BERTIN.

Naval architects and shipbuilders throughout the world will learn with great regret the news of the death, on October 22, of Mr. Louis Emile Bertin, the eminent French naval constructor, whose name has been prominent in shipbuilding circles of every country for the last sixty years.

Mr. Bertin was born at Nancy, in March, 1840; he entered the Paris Ecole Polytechnique at the comparatively early age of 18. When at that school, he selected as a profession that of naval architect, a profession in which he was to acquire very wide repute. From the Ecole Polytechnique, Mr. Bertin entered the Ecole d'Application du Génie Maritime, the French College of Naval Construction. On leaving this, in June, 1862, he was appointed on the naval construction staff at Cherbourg Dockyard. After the first five years spent in the designing offices, he took service on several battleships, and in November, 1868, he returned to naval construction duties in the same Dockyard. Mr. Bertin's period of service at Cherbourg lasted down to October, 1880, when he was nominated Engineer-in-Chief. At the latter date he was appointed to the Brest Dockyard, there to superintend the Department in charge of the construction of new units, a Department in which he was soon acknowledged as *primus inter pares*. The eminently successful way in which he had already solved very many of the problems surrounding the naval construction of the period, was becoming known over a wide circle; his work was greatly appreciated by the French Navy, and all the younger members of the profession looked up to him as the guide in whose footsteps they ought to follow. It may confidently be stated that from the date on which Mr. Bertin first took active service as a naval architect to the French Navy, he gave a most effective impulse to the scientific building of warships, an industry in which France had even before then occupied a prominent position. We may here remind our readers that in the paper which he read at the Jubilee Meetings of the Institution of Naval Architects, in 1911, Sir William H. White referred to "the valuable work done in the eighteenth century in the matter of naval architecture by France under the auspices of the Academy of Sciences, France having shown the way in recognising the advantages of scientific methods in ship construction." That a very large part of the progress achieved of later years by France, and by other countries also, in warship construction can be traced to the work carried out by Mr. Bertin, is generally acknowledged.

From the earlier years of his activity Mr. Bertin was entrusted both with the modification of older warships to render them suitable for different purposes and with the designing of new types, the work covering gunboats, corvets, troop transport ships, scouts, cruisers and ships of the line, and all the different innovations and improvements he introduced were ably and boldly conceived and carried into effect. At the same time, from 1868 to 1876, without any break in his active service, he published several works on scientific and historical subjects. These included, to name only a few, reports on the progress made in France in the realm of thermodynamics; a history of steam-driven naval and merchant ships from the introduction of steam propulsion; a book on waves and on the laws governing wave motion; a remarkable theory on the rolling of ships which found general adoption in the course of a very short time, and still serves as a guide for the discussion and the evaluation of the nautical qualities of a ship. This was followed by a report upon his double oscillograph. All these researches of his have been epoch-making in naval science.

A striking example of Mr. Bertin's activity, particularly during his earlier years at Cherbourg Dockyard is afforded by the fact that in 1869—seven years after he entered the Naval Service—he obtained his Licentiate's Degree at Laws in the Caen University. Later in life he became LL.D. At Cherbourg and at Brest his work was most important, and it may be asserted that no point connected with naval engineering and engineering generally escaped him, and progress followed in all matters to which he gave his attention.

As early as in the year 1872 or 1873 Mr. Bertin put forward one of his most important inventions, consisting in the provision, as a protective device for ships, of a cellular compartment or caisson built underneath the armoured deck below the water-line. This conception was much in advance of the times, since at that period and down to 1881 cruisers were built of timber. It was adopted in France in 1882 only, and for the first time on the cruiser Sfax, which was ordered to be built at Brest to the designs of Mr. Bertin. From this may be said to date the modern device of protection by cellular sub-divisions, a device which was ultimately adopted by all navies.

The Japanese Government in 1885 engaged the services of Mr. Bertin for reorganising the Japanese Dockyards and Fleet, and no better illustration than this could be given of the reputation he had achieved as a Naval Architect. Japan at that time had commenced her maritime development, a process which was soon to place her amongst the leading naval powers of the World. Japan ordered to be built in France, to Mr. Bertin's designs, the Matsushima and the Itsukushima, and at the Japanese Yokosuka Dockyard, which he re-organised, were built the Hashidate and the Yayeyama, the four units constituting a nucleus of French designed warships, armed with French artillery, that gave a preponderance to Japan in the Far Eastern wars which were fought a few years afterwards.

Mr. Bertin returned to the French naval service in 1890, and resumed his work, particularly his researches in the matter of cellular caissons, an application which he proposed to extend to battleships. At the same time he pointed out that in the case of several cruisers, in which the protection had been built in the meantime, the work had been done in such a way that the cruisers were liable to be placed in perilous conditions, from the point of view of stability in action. He explained matters by the aid of models, demonstrating the way in which a number of unstable ships had been constructed both in France and in other countries. He then got out the plans for a battleship in which he made due provision against the risk of instability.

Mr. Bertin was promoted in the Corps of Naval Constructors in 1892, and was appointed Governor of the Ecole d'Application du Génie Maritime, where he acted at the same time as Professor of Engine Construction. Later he was appointed Director of Naval Construction at the French Ministry of Marine, where he organised the Technical Section in Naval Architecture, a situation in which he greatly influenced the development of shipbuilding and the greater uniformity in the units forming the French fleet. From 1895 to 1905 Mr. Bertin designed numerous naval ships which gave renewed strength to the French Navy, practically down to the commencement of the Great War. To him were due, among others, the battle cruisers Jeanne d'Arc, Jules Ferry and Léon Gambetta; the cruisers of the Republique and Patrie class; the smaller cruiser Jurien de la Gravière; the monitor Henri IV. The programme governing the competition for submarine designs was started under his supervision, and it resulted, among other ships, in the series of Laubeuf submersible boats, the first of which was the Narval.

The direct connection of Mr. Bertin with the French Navy came to a conclusion in the year 1905 under the operation of the age-limit clause. But this did not mean a cessation of his activity, for during the last 19 or 20 years he published numerous scientific works and books of more general interest, all of which give evidence of his profound knowledge and literary achievements.

The French and foreign Governments duly recognised his services by conferring upon him the highest distinctions in their gift. Mr. Bertin had been for the last 20 years honorary president of the Association Technique Maritime et Aéronautique; as early as 1873 he was elected a member of our Institution of Naval Architects, and he was made an honorary member in 1896. His contributions to the Institution's Proceedings are the following: "The Experimental Study of Waves," "Relation between the True Period of Waves and the Period as observed on board a Vessel"; "The Amplitude of Rolling on a Non-Synchronous Wave"; "Hardened Plates and Broken Projectiles." Mr. Bertin was elected a member of the Académie des Sciences in 1903, while he was still in Government service. Mr. Bertin was also a member of numerous other French and foreign scientific institutions. He entertained most hospitably the Institution of Naval Architects on the occasion of their visits to France, the last event of this nature having taken place as recently as two years ago, when he was most active in his attentions to his guests in spite of his advanced age. His geniality acquired for him a very wide circle of friends who also respected him for his eminent scientific attainments.

PASS-OUT TURBINES.

At a meeting in Manchester of the North-Western Section of the Institution of Mechanical Engineers, held on Thursday, November 20, a paper on "Steam Extraction or Pass-out Turbines," was read by Messrs. W. S. Burge and J. P. Chittenden. In this the authors drew attention to the great economy with which power could be generated if there was a demand for large quantities of low-pressure steam for heating purposes or for chemical processes. Taking the hypothetical case of a factory requiring for such purposes 50,000 lb. of steam per hour at 30 lb. per square inch, the authors showed that a large amount of power could be very cheaply obtained if the steam were generated in the first place at 200 lb. per square inch and expanded in a turbine down to the pressure required for the heating system. Thus, with a boiler efficiency of 70 per cent. 1 lb. of coal might be expected to generate 7 lb. of steam at 30 lb. pressure. If the pressure were raised to 200 lb. and the steam superheated to 200 deg. F. the pound of coal would, on the same basis, provide 6·2 lb. of steam which, if expanded in a turbine down to 30 lb. per square inch, would yield 1,600 kw. if, as assumed, the total steam supply was 50,000 lb. per hour. This power would, therefore, be obtained for a net coal consumption of but 0·41 ton per hour. If the factory required this amount of power in addition to its heating requirements it would take 1·59 tons of coal to provide this power independent of the heating system. The latter might be taken to require 3·19 tons of coal per hour, making the total consumption 4·78 tons. With combined heating and power supply system, on the plan advocated, the total consumption for both purposes

would be 3·60 tons per hour. The authors described the governing gears used by different firms for such turbines. The difficulty to be met lay in the fact that in general the supply of steam required for heating purposes, and the demand for power, varied independently of each other. A second governor was required, therefore, which, as the demand for heating steam fell off, would pass on more to the low-pressure section of the turbine. This would tend to increase the electrical output, and hence the main turbine governor came into action and reduced the supply of steam to the turbine. In order to prevent hunting between the two governing systems, it was found advisable to interlock the two governors either mechanically or hydraulically. Various arrangements devised to this end were described in the paper. The authors, in the concluding section of their paper, drew attention to the great advantage of reduction gearing when applied to turbines of small or moderate output. This made it possible to run small turbines at very high speeds, thus reducing the diameter of the high-pressure portions, with a consequent decrease in leakage and frictional losses.

In the discussion which followed the reading of the paper, Professor Gerald Storey expressed the opinion that there was an immense future for small geared turbines running at 8,000 r.p.m. or more, at which speeds they became exceedingly economical. People, he said, were frightened of high speeds, but the usual speed for early turbines was between 8,500 r.p.m. and 13,000 r.p.m. The first turbine made by Sir Charles Parsons ran at 18,000 r.p.m. He, himself, had run a turbine up to 43,000 r.p.m., at which speed the brass rings had burst.

He strongly emphasised the advantage of the two-cylinder construction for turbines, and was glad to learn that nearly all builders were gradually coming round to this type. With this arrangement the high pressure and the high temperature was confined to the small high-pressure turbine. In modern power stations the temperature ranged from 750 deg. F. down to about 75 deg. F. The use of a single-cylinder, therefore, was almost comparable to putting one end in a furnace and the other in a freezing machine and expecting it to remain straight. With the two-cylinder arrangement two-thirds of the temperature drop occurred in the small high-pressure cylinder.

Dr. Morley said that the authors had only referred to the use of pass-out turbines, and not mentioned the application of the same system to reciprocating engines. There was, no doubt, a field for both, but the high-pressure part of a reciprocating engine had a higher efficiency than the high-pressure part of a turbine. He said that if records were kept of the pressure and temperature of the intermediate receiver, the performance of the high-pressure cylinder could be analysed, and in numerous cases he had found this to be of the order of 90 per cent. It was unquestionably possible to get up to an efficiency of 75 per cent. to 80 per cent. for the high-pressure element of such engines without going beyond normal ranges of pressure and superheat. He claimed for the reciprocator a further advantage when the pass-out steam was required at different pressures for different purposes.

Mr. Newton suggested that where steam was used for heating purposes and there was no local demand for power, the example set by the North Eastern Power Companies should be followed and the power available passed into electricity supply mains. He feared that the value of the pass-out turbine was not generally recognised by those in control of our manufacturing industries.

Mr. Dundas referred to suggestions that had been made for distributing for heating purposes exhaust steam from power stations. The cost of the street work would, however, be very large, but the system was in use in connection with the Dickinson Street Power Station at Manchester and extensions were being considered.

In reply, Mr. J. P. Chittenden agreed with Dr. Morley that the high-pressure part of a reciprocator was more efficient than the high-pressure part of a turbine. Other factors were, however, involved. The turbine required less expenditure on buildings, foundations and running costs, and it supplied, moreover, clean steam free from oil.

NOTES.

The West Midlands Electricity District.

The work of reorganising the electricity supply of this country proceeds by slow degrees and it is likely that a Joint Electricity Authority will soon be established for the West Midlands District. The area in question comprises the County Boroughs of Walsall, West Bromwich and Wolverhampton and portions of the counties of Shropshire, Staffordshire and Worcestershire. A draft order constituting the district and specifying the composition and duties of the Joint Electricity Authority has been issued by the Electricity Commissioners, who will hold a local enquiry at Wolverhampton Town Hall on December 16 for the purpose of finally determining the scheme. The proposed Joint Authority will consist of 16 members representing authorised electricity undertakers in the district, two representing local authorities who are not authorised undertakers, two representing railway companies and one representative of the Coal Owners' Association. The scheme provides for transference to the Joint Authority of the Birchells power station of the Walsall Corporation, the Ocker Hill station of the Midland Power Company and the Shrewsbury, West Bromwich and Wolverhampton Municipal stations. The transmission lines from Wolverhampton to Ocker Hill and Cannock will also be transferred. All the power stations mentioned are to be continued in service and extended, with the exception of that at Shrewsbury, where no further extensions are to be carried out. Immediate provision is to be made for a new capital station at Ironbridge, and for a number of interconnecting mains. Copies of the draft order may be obtained on application to the Electricity Commissioners, Gwydyr House, Whitehall, and any representations or objections should be made in writing before Tuesday, December 9.

The Franklin Institute.

The Franklin Institute has just celebrated the centenary of its foundation. Many distinguished visitors accepted the invitation of the Board of Management to be present, and Dr. Elihu Thomson delivered a highly interesting address, in which he sketched the history of the Institute from its commencement. The object of the founders, he stated, was to combine the idea of a Mechanic's Institute with that of a learned society. It was recognised that there was a great fund of practical information in possession of the skilled craftsman, of which those who pursued pure science were ignorant, and it was hoped that mutual interchange of knowledge might benefit both. The Charter granted by the State of Pennsylvania in 1824, provided for the delivery of lectures, and for the formation of a library and museum, and for (what we believe is a distinctive feature of this Institution), the examination by an expert Committee of new inventions and discoveries submitted to them. Dr. Thomson stated that, in 1877, at the age of 23, he was asked to deliver a course of lectures on electricity, and in the course of the experiments then made, he reversed the function of the windings of a Ruhmkuff coil, sending a small current through the secondary, and obtaining a large current in the primary. This, he stated, was the germ from which his method of electric welding was developed. The Journal of the Franklin Institute first appeared in 1826. Amongst the important work done by committees of the Institute, Dr. Thomson drew attention to the investigations made on water wheel efficiencies, on steam-boiler explosions, and into the shapes and proportions of screw threads. A valuable report on "The Conditions of Safety in Electric Lighting" was published in 1881. The Institute awards a number of medals for meritorious work in science or technology. These have a high international standing, having been bestowed impartially on leading men of all nations.

The Panama Canal.

The complete report for the year ending with June 30 last of the Governor of the Panama Canal shows that this waterway is coming very rapidly into use by shipping of all classes. The total net revenue of the canal, including railroad business, amounted to no less than 18¼ million dols., compared with just over 12 millions in 1923. The number of ships paying tolls using the canal had increased in the twelve months from 3,967 to 5,230, and the tons of cargo amounted to 26,994,710 compared with about 19½ millions in the previous year. The high figures, the report states, were partly due to the shipment of California crude oil. Beginning in September, 1922, these reached a peak in the same month of 1923 when 909,879 tons of crude passed the canal. Shipments, however, have since shrunk considerably, but the total for the year under notice amounted to 8,872,540 tons, compared with 303,724 tons for the year before. Other classes of traffic showing an increase in 1924 were lumber, accounting for 1,824,438 tons; nitrates, 1,744,580 tons; wheat, 1,352,388 tons; and iron ore, 888,198 tons. All these represented shipments from the Pacific to Atlantic ports. In the reverse direction manufactured iron and steel was the largest class. British tonnage, amounting to over 6,000,000, passed through the canal, but the U.S. tonnage amounted to 16,654,435 tons. The operation of the canal was satisfactory, and some increase of staff and change of organisation made it possible to deal with all vessels without delay. The lockages per diem averaged 14·3 at Gatun and just over 15 at Pedro Miguel and Miraflores. An accident occurred at Miraflores when a ship ran into the fender chain. This is the third incident of the kind on the canal, and in all cases the fender chain has operated satisfactorily and saved both the lock and ship from damage. At Pedro Miguel and Miraflores both chambers were available through the year. At Gatun the triennial overhaul of valves, gates, &c., was carried out, one chamber at a time, over a period of 41 days. The U.S. Pacific fleet of 65 vessels passed through the canal on two occasions, resulting, with commercial vessels, in a peak load of 145 vessels in five days. Power for operating the canal was derived from the Gatun hydro-electric and the Miraflores steam plants. The latter was used to a greater extent than previously, in order to conserve the water in the Gatun lake against the dry season. The Miraflores plant was further improved by the installation of an electric steam boiler, which is used when there is ample water available at Gatun. This produced sufficient steam to keep a 1,500-kw. steam turbine operating as a synchronous condenser for power factor correction, and at the same time was available for taking the Pacific lock loads on short notice in case of interruption. The survey of the Chagres Valley, in which it is proposed to place a dam at some future date, was completed and the entire basin of 21·2 sq. miles has been taken over by the United States, from the Panama Republic, and incorporated in the Canal Zone. The storage capacity which the dam would render available would amount to 22,310 million cub. ft. During the year floods caused some interruption of traffic. Rainfall on October 21 and 22 and again on the 24th, of an exceptional character, made it necessary to utilise the lock side-wall culverts in order to enhance the discharge through the spillway gates. In 48 hours no less than 27·9 in. of rain fell at Gatun. The earlier rain fell mainly in the Chagres River Watershed; the later storm extended directly over the Gatun Lake area. The bed of the Gatun Lake, standing at 86·10 ft. above sea level on Oct. 21, had risen to 87·48 ft. by Oct. 23, an increase in storage of 6,000 million cub. ft., although discharge was taking place at the spillway at the rate of 175,000 cub. ft. per second. It is estimated that during this time water entered the lake at the rate of 300,000 cub. ft. per second. No damage was done to the canal structures and the passage of ships was delayed little more than 9 hours. Shortly after this storm a slide occurred, which at intervals continued to give trouble until the following June, and altogether about 775,000 cub. yards of material had to be cleared from the canal prison. The total amount cleared from the Gaillard Cut during the year amounted to 3,694,400 cub. yards.

The Institution of Petroleum Technologists.—The Institution's Scholarship, which is granted to a Student Member of the Institution who is completing the Petroleum Technology Course at Birmingham University, has been awarded to Mr. Geoffrey Cotton.

LETTERS TO THE EDITOR.

"CLASS WARFARE TALK."

To the Editor of Engineering.

Sir,—I wish heartily to congratulate Engineering on the excellent article headed, "Class Warfare Talk," published in your issue of last week, with every word of which any reasonable man must agree. I think if that article could be reprinted as a leaflet and widely distributed by all employers throughout the country, and if the trade union leaders could be induced to persuade the unionists to read it, it would be a most incalculable benefit to the country. I myself propose to reprint a sufficient number for the workers in my company, and I hope others will do the same.

As a matter of fact, I know that an article which appeared in Engineering a week or two ago, on the "Working Day," has been reprinted by firms, and I think this article on "Class Warfare Talk" would be a very useful way of enlightening the working men.

I am, Sir, yours faithfully,
R. E. Crompton.

Crompton Laboratory, Thriplands,
Kensington Court, W.

WHITWORTH SCHOLARSHIPS.

To the Editor of Engineering.

Sir,—An analysis of awards in the competition for Whitworth Scholarships, 1924, shows that 26 (79 per cent.) of the 33 competitors receiving awards are students in three dockyards in the South of England; receiving 2,940*l.* (84 per cent.) of the 3,500*l.* awarded.

As an old Whitworth Scholar, I have always understood that it was the intention of the late Sir Joseph Whitworth that these scholarships should be open to, and awarded to, engineering students and apprentices in all parts of the United Kingdom.

It seems very desirable that Sir. Joseph's wishes should be carried out.

A. D. Ottewell, Wh. Sch., 1877.

14, Mill Hill-road, Derby.

[A table prepared by Mr. Ottewell, which we do not reproduce, gives a detailed analysis of the awards to which he refers. Candidates from Devonport Dockyard received one scholarship of 500*l.*, one of 375*l.* and seven prizes of 10*l.* each. Candidates from Portsmouth Dockyard received three scholarships of 753*l.* each, and five prizes of 10*l.* each. Those from Chatham Dockyard received ten scholarships of 375*l.* each and seven prizes of 10*l.* each, and a Pembroke Dockyard candidate received a 10*l.* prize. Three 10*l.* prizes went to the Royal Arsenal at Woolwich, and the only awards to students from non-Government employment throughout the whole country were a 500*l.* scholarship to a Sunderland man, and 10*l.* prizes to each of two candidates from West Hartlepool and Crewe respectively. The following table puts the main facts succinctly:—

—	Amount awarded.	Percentage Amount.	No. of Awards.	Percentage of Awards.
	£	per cent.		
Portsmouth ..	1,175	33·6	8	24·2
Devonport ..	945	27·0	9	27·3
Chatham ..	820	23·4	9	27·3
All others ..	560	16·0	7	21·2
Total ..	3,500*l.*	100·0	33	100·0

This is dealt with on page 741.—Ed. E.]

DISSOCIATION IN GAS ENGINES.

To the Editor of Engineering.

Sir,—Mr. D. R. Pye's letter in the current issue of your journal places his criticism of my paper on the "Missing Pressure in Gas Engines" recently read at the Institution of Mechanical Engineers, in an entirely different perspective. The manner in which he singled out the paragraph dealing with dissociation, his long explanation of the difference between dissociation and incomplete combustion and the figures which he quoted for the variation in the amount of dissociation with temperature, led those of us who listened to him to infer that he was attempting to explain that portion of the missing pressure unaccounted for by increasing specific heat and heat loss in terms of dissociation (*vide* the various press reports). But this portion of his statement at the meeting now seems to have been irrelevant, for he states in his letter that he agrees with me that dissociation in gas engines is negligible.

He appears, however, to be anxious to prove that incomplete combustion or after-burning is also negligible, and, since he has discarded the dissociation theory, his view is apparently that there is no defect in the pressures developed other than that which can be accounted for in terms of increasing specific heat and heat loss. My statement that in gas engines with normal ignition setting some 30 per cent. of the heat of combustion of the original charge is unaccounted for at the moment indicated by the peak of the indicator diagram he does not accept, and suggests that the experimental data from which I inferred this are "wholly unreliable."

Such a suggestion Mr. Pye would not, I am sure, have made, had he taken the trouble to apply the specific heat values of Pier and Bjerrum (for which he claims a high degree of accuracy, and which he has made fundamental to his work on the petrol engine) to the results of such gas-engine experiments with optical indicators as have been published. I believe the only comparatively recent experiments which have been published with sufficient data to enable the necessary calculations to be made are those by Sir Dugald Clerk, the late Professor Bertram Hopkinson and Sir Joseph Petaval and Professor Asakawa; but these are enough, and in each case the proportion of the heat of combustion unaccounted for at the peak of the indicator diagram is considerably greater when the calculations are made with the values of Pier and Bjerrum, than that obtained when my own values are used.

I think there is no doubt whatsoever that in gas engines with normal ignition setting a large proportion of the heat of combustion of the charge is unaccounted for at the peak of the indicator diagram by heat capacity and heat loss, and it seems to me that the only possible explanation is that of incomplete combustion or lack of equilibrium of some kind, which for practical purposes comes to the same thing.

Yours faithfully,
W. T. David.

Engineering Department, The University, Leeds.
November 24, 1924.

"THE RISK OF ACCIDENTS."

To the Editor of Engineering.

Sir,—Your article on "The Risks of Accidents" is as refreshing as a day by the sea, and its common sense shows how wide a gap exists between the "scientific" work of the Research Board and the practical needs of the workers into whose conditions the inquiry is made.

Countless other factors may have rendered the work of research inaccurate, *e.g.*, inadequate practice in handwork in school, circumstances at home which made satisfactory rest difficult to obtain, and—not least—the feeling that a visit to the ambulance room might be taken as an indication of clumsiness and might be reckoned against the person injured.

A really scientific inquiry might be useful alike to employers and employed, but the partial examination of insufficient data to which you refer, is not only unlikely to commend itself to practical men, but also extremely likely to arouse distrust amongst those whom it was originally intended to help. One cause of the trouble lies in the theory that it is the duty of the scientist to state facts rather than to draw conclusions.

The same pseudo-scientific tendency marks much of present-day research in psychology (whether of child or adult). One has the impression that it is the researcher rather than the child who is playing with a new set of toys (figures). The correctness or incorrectness of the answer may not matter quite so much to the child; for the employee it may mean being transferred to another process which is not so highly paid.

To inspire confidence under such circumstances is almost impossible, yet research work of this type has come to stay, and sooner or later almost every process of human activity will have its "expert," theoretically well trained, but too often practically unskilled, and generally of a different social class to the worker whose activity he is to control. Under such conditions there will be—if possible—an even greater need for the sanity and common sense which breathes in every line of your article.

I am, yours faithfully,
R. E. Roper, Educational Consultant.

14, Frognal-gardens, Hampstead.
November 24, 1924.

Institute of Transport.—A meeting to inaugurate the Yorkshire local section of this Institute will be held in the Council Chamber, Town Hall, Leeds, on Friday, December 5, 1924, at 6 p.m. Sir Lynden Macassey has promised to attend, and will be supported by Sir John Eaglesome, Mr. H. A. Watson, C.B.E., Mr. J. B. Hamilton, C.B.E., and many others prominent in transportation circles in the East and West Ridings of Yorkshire and in North Lincolnshire. Following the formal inauguration, the section will proceed to elect officers and determine its procedure for the first session. Non-members of the Institute may obtain invitations to the meeting by applying to Mr. R. Pegler, District Locomotive Superintendent, London, Midland and Scottish Railway, Leeds.

ELECTRIC LOCOMOTIVES FOR MONTREAL.

In January last the Harbour Commissioners of Montreal placed an order for four electric locomotives with The English Electric Company, Limited, of Queen's House, Kingsway, London, W.C. 2, this contract constituting the first part of a programme for electrifying the harbour lines of the city of Montreal. This electrification is being carried out owing to the great increase of traffic at this port which has to be handled between April and November, ice precluding working in the cold season. Two of the locomotives have now been completed and despatched to Canada, and some details regarding their construction will be of interest. The locomotives are capable of hauling trains up to a weight of 3,500 short tons. Of the 0-4-4-0 type, the locomotives work on a direct-current line voltage of 2,400. Each locomotive has a weight of 100 short tons, and is of the box-cab double-bogie articulated type, equipped with four 430-h.p. motors, having forced ventilation and working at 1,200 volts. Each motor drives through twin-spur gearing on to the axle, the driving wheels being 50 in. in diameter. The length of each machine is 40 ft. over buffers, the gauge of the track being 4 ft. 8½ in. The fixed wheel base is 9 ft. 3 in., the total wheel base being 28 ft. The supply to the locomotives, 2,400 volts direct current, is first transformed down from alternating current at 66,000 volts to alternating current at 2,300 volts, and then converted through motor generator sets in a sub-station at the docks.

Messrs. Beyer, Peacock and Co., Limited, of Manchester, supplied the trucks and superstructure. The motors and electric control equipment have been manufactured at the Preston works of the English Electric Company, where the locomotives were finally assembled and equipped. According to standard Canadian practice, they are fitted with automatic couplers, head lights, air-operated bell, and all standard fittings, such as air-brake equipment and brake-locks, have been made to standard American practice. The tractive effort at the wheel tread on a continuous rating is 32,000 lb. at 16 m.p.h. on a 1-hour rating and 43,000 lb. at 15 m.p.h. The normal tractive effort is 50,000 lb. up to 14 m.p.h., with a maximum of 60,000 lb. Control is by means of an "All Electric" camshaft for single or multiple unit driving, the control voltage being 110–120. Westinghouse brakes and two air-operated pantographs are fitted.

These locomotives possess special features to meet the conditions existing at the Montreal Docks. They will be constantly required to reverse direction for short hauls during shunting operations and without a view in both directions from the driving position there would be considerable danger on account of the large number of men who frequently cross the tracks. As it was impractical with a locomotive of this size to use the central type of cab, one end of the locomotive has been provided with front and rear views and also driving positions on both sides, so that the driver can conduct all operations from one end of the locomotive with a view in both directions. For long hauls the driving position at the leading end of the locomotive would be used. Details of the recent shipping of the first two locomotives are of some interest. The two superstructures are 35 ft. 9 in. long, 9 ft. wide and 9 ft. 3 in. high. These were conveyed by means of L.M.S. Railway Company 40-ton well trolleys. The bogies were conveyed in pairs on L.M.S. special platform trolleys, also having a carrying capacity of 40 tons. Three ordinary wagons carried the auxiliary equipment, while the motors were transported by road. Since the superstructures were out of gauge below platform level and the bogies above platform level, special railway arrangements were necessary, the consignment being carried by a special train at night.

The transference of the bogies and superstructures from rail vehicle to the Manchester Ship Canal Company's 60-ton floating crane and thence loading into the steamer Manchester Regiment was safely completed. The great length of the superstructures necessitated their being loaded into the steamer in a tilted position at an angle of about 30 deg.

Royal Aeronautical Society.—The Council of the Royal Aeronautical Society have decided that no paper submitted in 1924 for the R.38 Memorial Prize is of sufficient merit to justify an award. In the circumstances it has been decided to award the prize for 1924 to Messrs. C. P. Burgess, J. C. Hunsaker and S. Truscott, for their paper on "The Strength of Rigid Airships," which was submitted in 1923.

Institution of Municipal and County Engineers.—It is announced that a meeting of the Scottish District of the Municipal and County Engineers will be held at Glasgow on December 3. Members are requested to submit proposals regarding subjects for discussion, and those who intend to be present are requested to notify the Hon. District Secretary, Mr. William Watson, Borough Surveyor, St. Andrews, and to meet at the City Chambers, Glasgow, at 11 a.m., on the above date.

THE MANUFACTURE OF HEAD TELEPHONES FOR WIRELESS RECEPTION.

Since the London station of the British Broadcasting Company was inaugurated about two years ago, the company have installed eight additional main stations and nine relay stations in different parts of the country, and are also operating the high-power station at Chelmsford referred to in our issue of October 3 last, on page 494. It is thus now possible for the population of practically all the main centres of industrial or commercial activity to obtain the entertainment and instruction provided by the broadcasting service with the simplest and most inexpensive apparatus. Practically the only component of a crystal receiving set which is beyond the capacity of an amateur mechanic to produce for himself is the head telephone, and that he must perforce purchase from the manufacturer. As might be expected, therefore, the demand for this particular component has grown to a remarkable extent, and to supply this demand it has been necessary for manufacturers of telephone apparatus to produce designs in which the requisite high efficiency and good acoustic properties can be obtained by mass production manufacturing methods; the latter are, of course, essential to enable the product to be retailed at a sufficiently attractive price.

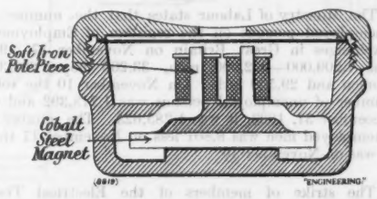
The manufacture of wireless apparatus, including valves, receiving sets, loud speakers and head telephones now forms an important item in the activities of the British Thomson-Houston Company, Limited, being carried on, with the exception of the manufacture of valves, at their Alma-street and Lower Ford-street works at Coventry, where the well known B.T.-H. magnetos are also made. Quite recently the firm have produced a new design of head telephone especially intended for the reception of broadcast telephony and these telephones, we understand, are now being manufactured at the rate of about 11,000 pairs a week. As would be expected, many interesting operations are involved in the production of such comparatively complex articles on a large scale, and these operations we have recently had an opportunity of witnessing during the course of a brief visit to the Coventry works.

The telephone, it should be explained, comprises a headband consisting of a suitably shaped loop of steel wire covered with leather sleeves and fitted at each end with a Duralumin stud in which slides a stirrup, also of steel wire, carrying the earpiece. By sliding the stirrups in the studs, the distance between the earpieces can be adjusted to suit the width of the user's head and to regulate the pressure on his ears, but this light pressure being exerted practically at right angles to the direction in which the stirrups slide in the studs is sufficient to maintain the correct adjustment as long as the telephones are in use. The weight of the telephones, complete with flexible cords, is only 9½ ozs. Several interesting machines and operations are employed in the production of the headbands and stirrups, but owing to limitations of space we must confine our attention to the production of the earpieces, which are, of course, the most important details.

From the cross section of one of these parts, reproduced in the accompanying illustration, some unusual features of the design will at once be apparent. It will be noticed, for instance, that the greater part of the magnetic material is embedded in the moulded composition forming the body, only the tips of the pole pieces, which carry the coils, projecting through the composition. We should mention, in connection with the magnetic system, that the permanent magnet consists of a rectangular bar of cobalt steel, to which soft-iron pole pieces, of the form shown in the illustration, are attached by pressing. The remarkably high magnetic retentivity of cobalt steel gives a powerful field for the minimum weight of material. Another point to which attention may be called is that the diaphragm, which is of Stalloy, is clamped at its periphery between the cap and body of the earpiece without the usual metal clamping ring. The avoidance of metal parts as far as possible is, of course, of importance in reducing resonance effects.

The composition used for moulding the cap and body of the earpieces is a mixture of Bakelite synthetic varnish and wood meal, the materials being first ground and thoroughly mixed together into the form of a brown powder. For moulding the caps, the requisite quantity of powder is pressed into disc form, for convenience in handling, and the discs are put into polished steel moulds. The latter are then placed between steam-heated platens in hydraulic presses, where they remain for about 10 minutes. The combined heat and pressure forms the powdered material into a hard solid substance, which is light and non-resonant in character and similar to vulcanite in appearance, although brown in colour. The screw thread shown in the illustration is formed in the mould, and the only subsequent treatment required is the removal of the fin formed, the clearing out of the central hole, and the buffing of the front face which comes into contact with the ear. The moulding of the body of the earpiece is carried out in a similar manner, except that the material is filled into the mould in the form of a loose powder after the magnet system has been placed in position. To complete the body after removal from the mould, the fins produced at the joint in the mould are ground off and the upper rim, which constitutes the diaphragm clamping surface, is finished flat by grinding; the ends of the protruding pole pieces are also milled and ground off so that they terminate between 0·011 in. and 0·0135 in. below the rim of the body. The dimensions given are, of course, the limiting lengths of the air gap between the pole faces and the Stalloy diaphragm, and to ensure accuracy within those limits each earpiece is checked by means of a dial gauge. Three holes are also drilled simultaneously through the sides of the body, two to take the turned-in ends of the stirrup and the other one to allow the flexible leads to pass through. The final operation on the bodies before assembly, is the magnetising of the permanent magnet which is effected by placing the bodies two at a time on the poles of a powerful electro-magnet and switching the current on and off two or three times; the strength of the remanent flux is checked for each earpiece by means of a coil and ballistic galvanometer.

The assembly of the completed components is carried out in a separate room on the top floor of the Alma-street factory, in which room about 400 women and girls are employed in five groups, each constituting a complete and self-contained unit. In this room, the coils are wound with fine enamelled copper wire on formers stamped in one piece from thin sheet brass. The majority of the coils are wound for a resistance of 1,000 ohms each, giving the complete head 'phone a



total resistance of 4,000 ohms, but head 'phones with a total resistance of 120 ohms are also supplied for use with telephone transformers. The coils, to which tag connections have been soldered, are placed on the pole pieces and the tags are pressed into blind holes moulded in the body, together with the ends of the flexible leads, a tubular rivet being also forced into each of the holes to ensure the maintenance of a perfect contact; no external terminals or other projections from the body of the earpiece are thus required. It may here be mentioned that no metal screws are used in these telephones, the only screwed joint of any kind being that for connecting the cap with the body of the earpiece. When the coils have been placed in position and the connections made with the flexible leads, the diaphragms are inserted and the caps screwed on, the operations being completed by the fitting of the headband and stirrups.

Each pair of telephones, when finished, is placed in a cardboard box and dropped through a chute, provided with a trapdoor, on to a band conveyor, and the boxes travelling on the conveyor are collected at the end of the room and passed on for final inspection and testing before despatch. The movement of the trapdoor as each box is passed through is made to operate large dial indicators at the end of the room, one indicator being provided for each group of workers, so that the production of the various groups can be seen by the charge hands and other officials, as well as by the workers themselves. The arrangement not only enables any diminution in production to be detected and its cause removed at the earliest possible opportunity, but also encourages a healthy competition between the groups with respect to output.

In conclusion, we may mention that although each stage of the manufacture and assembly of the components is carefully checked by inspection and testing, a particularly elaborate series of tests is carried out on each pair after it is finally completed. An audibility test is made with both speech and music supplied by a gramophone transmitter, and sensitivity and sound-balance tests are also made; the object of the latter is to see that the volume of sound produced by the two earpieces constituting a pair is exactly equal. One point of interest in connection with this testing work is that some men blinded in the war are at present employed on it with highly satisfactory results. Such work would appear to be particularly suitable for sightless men whose sense of hearing is generally very acute, and who are able to concentrate their attention continuously on the work upon which they are engaged. It is, therefore, to be hoped that their employment for this and for similar duties will be extended as far as possible.

THE CARDIFF ENGINEERING EXHIBITION.

An engineering exhibition at the Drill Hall, Cardiff, promoted by the South Wales Institute of Engineers, was formally opened yesterday, Thursday, by the Lord Mayor of Cardiff, Alderman W. H. Pethybridge. In addition to the welcome extended, on behalf of the City, by the Lord Mayor to the exhibitors, Mr. W. A. Chamen, the President of the Institute, delivered an address of welcome. The exhibition will be of the greatest interest to those concerned with the application of modern machinery to mining work, but there are many exhibits of a more general engineering interest. The Institute and its secretary, Mr. Martin Price, deserve the congratulations of the engineers in the South Wales district for their enterprise in organising this excellent display of plant, and if the qualities of the exhibits are any criterion of the success which will attend the venture, the participating firms will have little reason for regret when the exhibition closes on Saturday, December 6.

In the period during which the exhibition is open a series of meetings have been arranged by the Institute in association with the kindred societies in the district, and cinematograph demonstrations to show coal cutters at work have been arranged with Messrs. Mavor and Coulson, Limited, and Messrs. Hugh Wood and Co., Limited. On Monday next Mr. W. B. Lewis will present a paper prepared by Mr. G. S. Irving and himself on "The Scientific Treatment of Boiler Feed Water, introducing the Colloidal Aspect." In the evening the members are invited to take part in the discussion at the Western Centre of the Institution of Electrical Engineers on a paper by Mr. G. Rogers on "Automatic and Semi-Automatic Rectifier Sub-stations." Three lectures are to be given, on Tuesday, Wednesday and Thursday, by Mr. W. E. Bush, of the Lighting Service Bureau of the Electric Lamp Manufacturers' Association, on "Modern Electric Lighting."

Personal.—We are advised that no change will be made in the title of the firm of Coode, Fitzmaurice, Wilson and Mitchell, of 9, Victoria-street, Westminster, consequent on the death of Sir Maurice Fitzmaurice. The business will be carried on by the surviving partners. —The ownership of the Cooper Roller Bearing Company, of King's Lynn, has recently changed, and the new proprietors have appointed Mr. C. A. Ablett, M.Inst.C.E., as managing director. This gentleman is also managing director of the Unbreakable Pulley and Mill-Gearing Company, Limited, of Manchester.

The Institution of Engineering Inspection.—The opening meeting of the session of the Institution of Engineering Inspection took the form of a social gathering in the Hyde Park Hotel on Tuesday, November 25. In opening the proceedings, Mr. Francis R. Wade delivered his presidential address, in which he dealt with some of the problems confronting the industrial leaders at present. He advocated the use of funds for development purposes in the Dominions and Crown Colonies, as one of the most effective means of reducing unemployment at home. Afterwards a dance was held.

Iron and Steel Production Statistics for October. —It is announced by the National Federation of Iron and Steel Manufacturers that the production of pig-iron in October of this year amounted to 586,400 tons, compared with 569,200 tons in the preceding month, and 595,700 tons in October, 1923. The number of furnaces in blast was increased by 1 to 171 during the month under consideration. The production included 192,900 tons of hematite, 185,300 tons of basic, 157,700 tons of foundry, and 28,500 tons of forge pig-iron. The output of steel ingots and castings in October amounted to 678,500 tons, compared with 645,000 tons in September of this year and 702,200 tons in October, 1923.

Contracts.—Messrs. Hartley, Sons and Co., sewage machinery engineers, of Stoke-on-Trent, have received a further order from the Leeds Corporation for 6 acres of their power-driven, rectangular, patent wind-balanced sewage distributors. This will make 18 acres of distributors this firm will have installed for the Leeds Corporation.—The Underfeed Stoker Company, Limited, of Aldwych House, London, W.C. 2, have recently secured orders for four Underfeed stokers for the United Alkali Company, Limited, of Victoria Docks, London, E. 16, and also contracts for air heaters for the Lansdowne Jute Mills, at Belgachia, India, and ash conveyors for the Darlington Corporation.—The High Commissioner for the Union of South Africa has placed an order with the Leeds Forge Company, Limited, of Leeds, on behalf of the South African Railways Administration for the supply of a pair of coach underframes and bogies specially designed on the articulated principle. The bodies will be built in South Africa. These coaches are intended for the use of the Governor-General, and in the first instance will be employed in connection with the forthcoming visit to South Africa of H.R.H. the Prince of Wales.

LABOUR NOTES.

As strike strategy has been a sort of obsession with Communists since the end of the war, it is not surprising to hear that it formed the subject of a serious debate at the recent World Congress of the Red International of Labour Unions. So far as we have been able to gather, no official report of the discussion has been published, but a writer in the official organ of the British Bureau leaves us in no doubt as to the line it took. The strikes of the future must, he declares, be strikes that are carefully prepared for with full cognisance of all the factors involved. Instead of spontaneous strikes—instead of weakly conducting a struggle against the prepared organised forces of Capitalism, in a whirl of emotionalism—we must, in his opinion, have strikes that are carefully prepared for months beforehand, with those leading them in possession of exact detailed information concerning "the enemy," and able to utilise to the utmost on the side of the strikers all the industrial and political forces of the working class movement. Every trade union headquarters should, he says, systematically gather together all the information it is possible to obtain concerning the bodies of employers against whom they are likely to conduct strike actions—their shareholders, contracts, personnel, business ramifications, &c. Without that information, it is explained, it will be impossible for the leaders of strikes to search out the strength and weakness of the Capitalists and to know when to attack and how to attack.

Means should be created, the writer goes on to say, of attracting the women—the great weak link in all strike warfare—to support the workers in every action. How many strikes have failed in the past, he asks, because the women in the strikers' houses have not been able to grasp their significance and have consequently weakened the *morale* of their men-folk? How many strikes have failed in the past, he asks, because of the lack of bare provisions for feeding the strikers? Yet we have in this country, he points out, a powerful, organised, essentially working-class movement—the Co-operative movement—whose material aid during industrial disputes has never been consciously sought or intelligently organised.

Other causes of failure are cited by the writer, but those which we have given fairly well explain, we think, why the Red International or Labour Unions is, in this country, at any rate, a minority movement.

In a letter which is printed in the November issue of his organisation's "Journal," a member of the Amalgamated Engineering Union alludes to the activities of the National Minority Movement, and expresses the opinion that the sooner the sane trade unionists of the country put their foot down the better. "It is," he declares, "through the constant interference of these bloodthirsty rebels of society that we find ourselves unorganised and divided. Surely," he adds, "the trade unions are democratic enough. They give you an opportunity to express yourself and to alter that which you think is wrong. With this power, used along with the political power, you will get on the high road to progress, and instead of forming more movements make the one you have perfect. Let us fight for a Federation of Trade Unions on the lines of the F.B.I. and then we can talk about striking a blow at capitalism."

"Russian Information and Review," the organ of the London Trade Delegation of the U.S.S.R., states that highly important proposals are now being worked out for the operation of Labour Exchanges in Russia in order to cope with the increasing demands upon them by the comparatively rapid development of Soviet industry. Already regulations have been issued to facilitate the participation by employers in the selection of the labour they require. Employers have also been empowered to engage certain classes of workers without the intermediary of the exchanges, provided that such transactions are registered there. It is now proposed to proceed further in this direction by transforming the Labour Exchanges as a whole into intermediary bodies, to which application for work by workers and for labour power by employers, is to be purely voluntary. At the head of these bodies it is proposed to place a committee composed of representatives of the trades unions and economic departments, the chairman being a representative of the Labour Commissariat. Although it will be no longer compulsory to hire labour through these bodies, the Labour Commissariat will continue to participate in the regulation of the labour market.

According to Mr. George Hicks, the general secretary of the Amalgamated Union of Building Trade Workers, comparative figures cited to prove that building production is scandalously low are the kind of figures that notoriously lie. To the uninstructed, he says, they appear convincing. The case against the bricklayer seems abundantly clear when it is stated that pre-war production was so many bricks a day against so many fewer at the present time. The fallacy of the comparisons is exposed, he claims, in the fact that "production" is an aggregate of rough work with "faced" and angle work, &c., and that most of the old rough work is done away with in post-war construction by the substitution of concrete rafts for under-building, *i.e.*, foundation work and slab partition walls.

At the eighth annual industrial conference of the New York State Department of Labour, which is to take place in New York City next week, the broad theme set down for discussion will be "The Maintenance of Peace and Stability in Industry." Under that general head it is proposed to consider (1) the peaceful solution of disputes, (2) the character of labour's participation in the conduct of industry, (3) the effect of the shorter working day, (4) co-operation in accident prevention, (5) the health of the workers. Employers and employees will take part in the discussions and speakers with national and international reputations are expected.

Whilst there is nothing to justify prophecies of a great boom in trade, states "Man and Metal," the organ of the Iron and Steel Trades Confederation, there is some ground for the belief that we have seen the worst of the recent slump and are now on the way to a gradual recovery. September steel production showed a gain of about 118,000 tons over that of August, the output for August being 537,500 tons and for September 645,000 tons. The American output of steel provides a useful barometer, by which to gauge the future movements of the industry, and that has shown a further gain in September following upon the very marked recovery in August.

The Ministry of Labour states that the number of unemployed persons on the registers of Employment Exchanges in Great Britain on November 17, 1924 was 1,209,000—922,000 men, 33,200 boys, 224,300 women and 29,500 girls. On November 10 the total number of unemployed persons was 1,218,392 and on December 31, 1923, it was 1,285,623. The number of unemployed men was 8,801 less on November 17 than it was on November 10.

The strike of members of the Electrical Trade Union at the new Barking super-power station was considered on November 21 at a meeting of the No. 10 Area Joint Industrial Council for the electricity supply industry. It transpired that earlier in the week the trade union representatives on the Standing Committee had suggested "that in all future contracts it shall be stipulated that men carrying out work in London power houses and sub-stations, similar to that done by those grades specified in Clause 15 of the Number 10 agreement, shall receive the rates of pay provided for in that clause." The reply of the employers was embodied in a resolution which was submitted at the meeting of the Joint Council. The resolution was as follows:—

"That in the opinion of this side of the council the proposition of the union representatives contemplates action which at present is *ultra vires*, the constitution not providing for any supervision by this Council of conditions inserted in contracts placed by electricity undertakings. This side of the Council therefore, is not prepared to proceed further than to refer the proposal to the employers' associations by which it is appointed with a view to obtaining a joint conference at which such associations can jointly consider the proposal of the trade union side and, if it is agreed to be necessary, can formulate instructions as to enlarging the powers of this Council."

The resolution was adopted, the trade union side of the Council registering their dissent from the view of the employers that the action proposed by the trade unions was beyond the powers possessed by the Council. In response to an appeal by the chairman, assurances were given on behalf of the employers and of the union that nothing would be done pending the carrying out of the resolution to interfere with the settlement of the dispute.

On November 24 a Conference on the Barking trouble took place at Broadway House, Westminster, between representatives of the Engineering and Allied Employers National Federation and representatives of the London District of the Electrical Trades Union. The subject discussed was described on the memorandum of the Conference as "rates of wages to be paid by federated employers on erection and installation of, and other work done in connection with, electrical plant and machinery in the metropolitan area." It was mutually agreed that the disputes "at present pending" on the foregoing question should cease; and that the firms concerned should continue their usual practice as to rates of wages payable. The workpeople on strike at Barking and Romford were to be given an opportunity to resume work on November 25, and any who did not then present themselves for re-employment were to be taken on thereafter only if possible. Men who had left the district were to be given a reasonable period within which to present themselves. The workpeople, on resumption, were not to interfere with any employees at present engaged on any of the contracts in the area, and the employers were not to victimise any of the men for their part in the disputes.

The position of the Engineering and Allied Employers National Federation in relation to the negotiations of the Electrical Trades Union with the employers' side of the Joint Industrial Council for the electricity supply industry was clearly defined. It was mutually agreed that "the Federation and Federated Employers are not members of, nor are they parties to, the deliberations of No. 10 Area Joint Council on the question of contract clauses in future contracts" and that "the Federation and the Federated Employers and the Electrical Trades Union reserve their rights respectively to take such action as they deem desirable on any decision which may follow the deliberations of the Council."

According to the organising delegate at Preston of the Amalgamated Engineering Union a wages question at the works of a local firm has taken an unusual turn. The men asked for an increase and, on their demand being refused, they threatened to strike. A number of conferences took place, and eventually the firm offered a bonus on profits. "We are at present," the delegate says, "hammering out the scheme before it goes for final acceptance by the men."

A speech to a conference of metal workers by Dzerzhinsky, head of "Glavmetall," the State Department which controls Soviet Russia's metal industries, is summarised in a message from the *Times* correspondent at Riga. Dzerzhinsky, who is also chairman of the Supreme Economic Council, said that in 1923–24, the total metal industries employed 194,000 workmen, but the programme for the next year would provide for an increase to 219,000. The past year showed some bright features, but nevertheless the metal-working industries had only reached 27½ per cent. of the pre-war output. Before the war Russian industries used 72 lb. of cast-iron per head of the population, but in 1923–24 they used only 14 lb. The development of the metal industries would require grants from the State, but it was impossible to provide these without jeopardizing the stability of the currency. Accordingly the revised estimate of the "Glavmetall" contemplated a decreased production from 306 to 270 million gold roubles.

Dzerzhinsky believed it would be advisable to relax the barrier against the import of metal products. It would be much more profitable to import certain metal articles than to produce them by financing Russia's own metal industries. The metal industries were now a great burden to the finances of the State, and only rational working, which was lamentably absent, could make them profitable. He said that a foreign loan would be useful, but there was danger that under the prevailing conditions it might be "eaten up" without bringing beneficial results. Without a loan they must manage with their own resources.

Mr. W. A. Appleton, the Secretary of the General Federation of Trade Unions, reports that the quarter ending September 30, in addition to showing a slight increase in membership, also showed an increase in the organisation's accumulated reserves. The claims for dispute benefit had also been a little higher. There had been 43 disputes involving 4,435 persons and an expenditure under this head of 4,941*l.* 12*s.* 6*d.* The major portion of that increase in benefit expenditure arose through the building trade dispute. Some of the building trades, Mr. Appleton says, never went any further with the idea of general federation than the drafting of the rules. Others joined the General Federation and seceded when the Building Trades Federation came into existence; but some few unions which joined refused to secede, and these, during the dispute, received Federation benefit to the extent of 2,000*l.* The income during the quarter from contributions was 13,499*l.* 14*s.* 3*d.*, and the expenditure on benefits 4,941*l.* 12*s.* 6*d.* The membership on which contributions are paid is 777,511.

SPECIFICATION FOR SPANNERS.—The British Engineering Standards Association has just issued publication No. 192–1924, entitled "Dimensions of British Standard Spanners." In this specification all dimensions necessary for setting out spanners to the new design up to 2 in. size are given in tabular form. Notes are included on the angles between spanner head and shank, and on the standard method of marking. Both B.S.W. and B.S.F. bolt sizes are covered. Copies of the publication may be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W., price 1*s.* 2*d.* post free.

THE WADE BACK-GEARED SCREW-CUTTING LATHE.

CONSTRUCTED BY MESSRS. C.A.V. SMALL TOOLS, LIMITED, ENGINEERS, HOVE, SUSSEX.

Fig. 1.

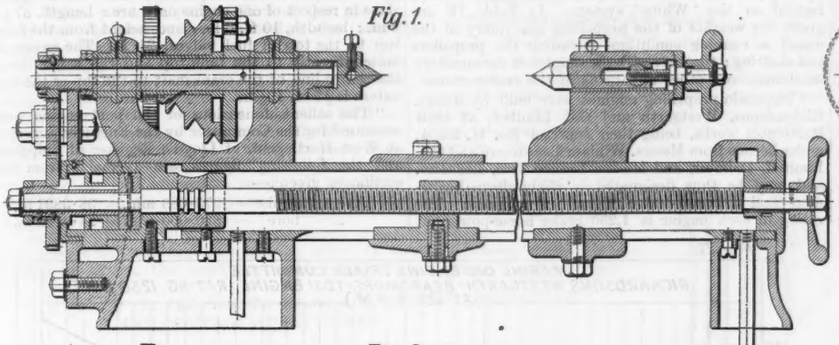


Fig. 3.

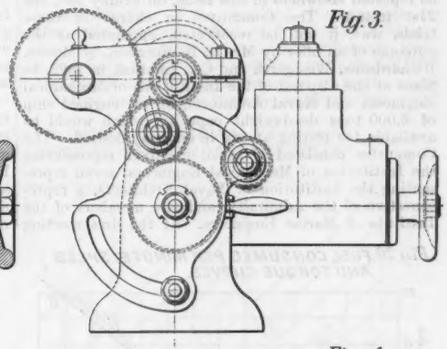


Fig. 2.

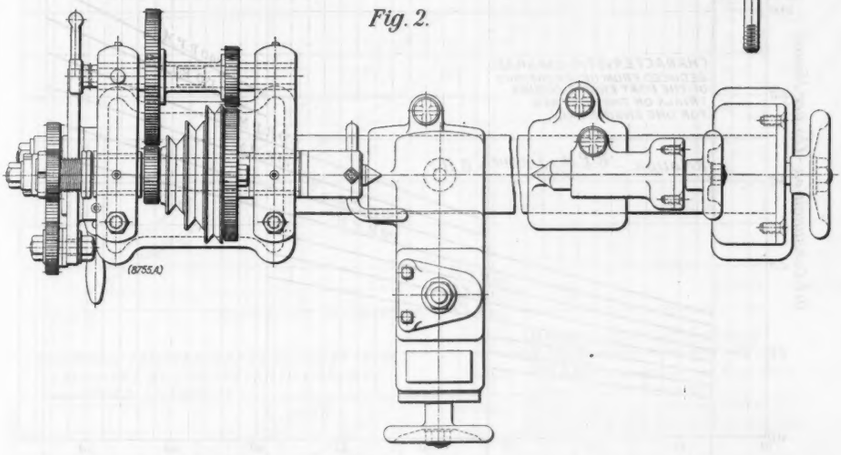
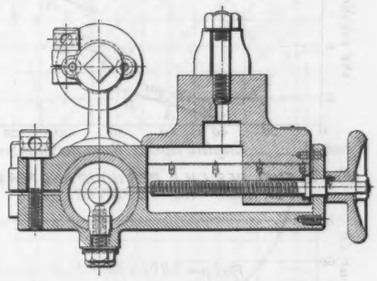


Fig. 4.



"ENGINEERING".

THE WADE BACK-GEARED, SCREW-CUTTING LATHE.

In our issue of March 16, 1923, on page 342, we illustrated and described a small, simple lathe suitable for use by model makers and amateur mechanics, and designed so that, by employing methods of mass production in manufacture, an accurate and reliable tool could be produced at a sufficiently low price to be within the reach of practically all prospective users. We are referring to the Wade lathe made by Messrs. C.A.V. Small Tools, Limited, at their works in Hove, Sussex, and the fact that many thousands of these little tools have been sold since their introduction is an indication that they have met the requirements of a large and increasing number of persons interested in the production of mechanical appliances as a hobby. In the hands of an ingenious amateur mechanic, to whom the time occupied is not of primary importance, the simple Wade lathe can be used for a surprisingly wide range of machining operations for which specialised tools would be employed in an engineering workshop. The more experienced amateur, however, must frequently have realised that the utility of the tool would be greatly extended by the addition of back gearing, with a self-acting feed for the saddle and screw-cutting mechanism.

To meet the need for an inexpensive lathe of this type, the makers, comparatively recently, have introduced the new model which we illustrate in Figs. 1 to 5 above. This is known as the Wade No. 2 lathe, and while its general design and construction follow closely on the lines of the original model previously described, the fixed headstock has been completely re-designed to accommodate the back gearing and the change wheels for driving the leading screw. From the longitudinal section and plan reproduced in Figs. 1 and 2, the end elevation of the fixed headstock, Fig. 3, and the transverse section of the saddle, Fig. 4, the construction of the lathe can be followed with but little explanation, while a good idea of its general appearance is given by Fig. 5.

The spindle, as shown in Fig. 1, is hollow, and is turned out of the solid from mild steel. It is of ample length to enable the gears to be easily changed and to be held concentrically. The white-metal bearings of the spindle are adjustable for taking up wear, and the cone pulley is fitted with a gun-metal bush. The back gears give a speed reduction ratio of 5 : 1. They are of mild steel, machine cut from the solid, and are pressed and pinned on to a mild-steel hub, running on an eccentric shaft of phosphor bronze. A ball-ended pin, best shown in Fig. 2, is provided to throw the back gear into or out of engagement. The change wheels are also of mild steel, machine cut from the solid, with teeth of 28 diametral pitch and $\frac{5}{16}$ in. in width. Fourteen change wheels are provided, which are sufficient to enable right-handed or left-handed threads of English or metric pitches ranging from 6 to 60 threads per inch to be cut. The banjo plate, shown in Figs. 3 and 5, is a casting of a tough aluminium alloy and can be easily adjusted and rigidly fixed in position by means of a stud. The sleeves for the change wheels, for use when compounding or for the idler gear, are of gun-metal in order to reduce any tendency to seize. The clutch for driving the leading screw, shown in section in Fig. 1, is of mild steel, bushed throughout with gun-metal, and is located so as to be completely protected from chips and dirt; the handle operating the clutch is conveniently located on the left of the headstock, as shown in Fig. 5. The leading screw, which is cut with 12 threads per inch, runs in a gun-metal bush at the tailstock end and in a combined thrust and journal bearing of white-metal at the headstock end. The bed, as in the original model, consists of a ground steel tube in which the leading screw is enclosed, a longitudinal slot being cut in the bottom of the tube to guide the tailstock and saddle, and to enable the latter to be connected with the nut on the leading screw. The nut is solid, and a hand-wheel is provided at the end of the lathe for the longitudinal adjustment of the saddle, which is fitted with cross feed and gives sufficient clearance to enable work up to 4 in. in diameter to be turned; it has a longitudinal travel of 12 in.

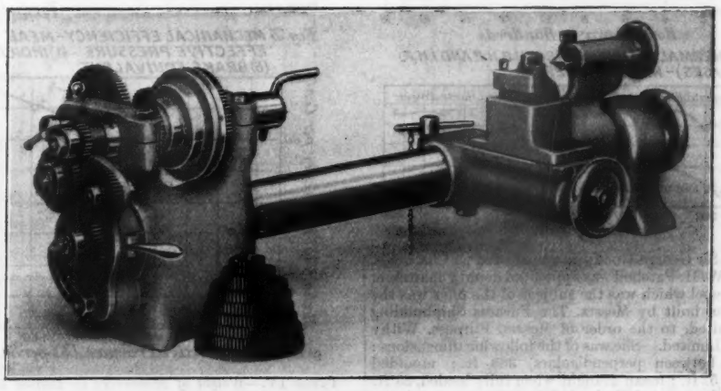


Fig. 5.

The lathe complete, as illustrated in Fig. 5, is retailed at the remarkably low price of 6*l.* 10*s.*, which we mention as an instance of the manner in which production costs can be reduced by careful attention to design and manufacturing methods when the demand for the product is sufficient. Various accessories, such as a foot motor, face plate, self-centring chucks, drill chucks, &c., are supplied at correspondingly low figures. The London address of Messrs. C.A.V. Small Tools, Limited, is 181, Queen Victoria-street, E.C. 4.

MARINE OIL-ENGINE TRIALS.

THE first report of the Marine Oil-Engine Trials Committee was presented and considered at a general meeting of the Institution of Mechanical Engineers, as reported elsewhere in this issue, on Friday last, the 21st instant. The Committee in charge of these trials, was, it will be recollected, appointed as the outcome of an offer by Mr. D. B. Morrison, of Messrs. Richardsons, Westgarth and Co., Limited, in 1922, to place at the disposal of the Institutions of Mechanical Engineers and Naval Architects, an oil engined ship of 6,000 tons deadweight capacity, which would be available for testing at sea in any way desired. The Committee consisted of seven members representing the Institution of Mechanical Engineers, seven representing the Institution of Naval Architects, a representative of the Admiralty, and two members of the Institute of Marine Engineers. At the first meeting Admiral Sir George Goodwin was elected as Chairman, and Mr. W. H. Patchell was appointed deputy chairman.

The vessel which was the subject of the offer was the Sycamore, built by Messrs. The Furness Shipbuilding Co., Limited, to the order of Messrs. Furness, Withy and Co., Limited. She was of the following dimensions: Length between perpendiculars, 363 ft.; moulded breadth, 52 ft.; mean draught when fully loaded, 23 ft. The displacement fully loaded is 9,200 tons, and the deadweight capacity, as stated, 6,000 tons. Her estimated service speed is 11·5 knots, and the designed aggregate power of the propelling machinery is 2,500 shaft horse-power, developed in 2 units.

The report on the trials now completed covers 123 octavo pages, and being of so great a bulk is unfortunately not suitable for reproduction *in extenso*. We have been compelled, therefore, to select portions of it only for publication, and have confined ourselves mainly to giving the results arrived at. In the original document these only occupy a portion of the total space, the remaining material relating to a most detailed statement of the conditions under which the trials were made, of the instrument and methods of measurement adopted, and a complete description of the engines on which the trials were made. In the following summary where any section is taken *verbatim* from the report it is shown quoted. Throughout, for convenience of reference, the original Committee's numbering of tables and figures has been retained.

The Sycamore carries 678 tons of oil-fuel for the engine, and 481 tons for boilers. The estimated endurance of the vessel is 20,000 nautical miles. "The supply of steam for auxiliary purposes, including the evaporator, is taken from a pair of 'Cochran' vertical multitubular boilers placed at the aft-end of the engine-room. Each boiler is 18 ft. 6 in. high by 8 ft. 6 in. diameter, and has a heating surface of 1,000 sq. ft., the normal pressure of steam supply being 120 lb. per square inch. The furnaces are arranged to burn fuel-oil on the 'White' system. In Table IV are given the weights of the propelling machinery of the vessel in running condition, including the propellers and shafting; together with the weights of the auxiliary machinery and other apparatus in the engine room.

"The main propelling engines were built by Messrs. Richardsons, Westgarth and Co., Limited, at their Hartlepool works, being their contract No. H. 2,554, under licence from Messrs. William Beardmore and Co., Limited, Dalmuir, and Messrs. Franco Tosi, Legnano, and may be thus designated: 'Richardsons-Beardmore-Tosi Director-Valve Type' oil engines. The rating of each engine is 1,250 brake horse-power, at 125 r.p.m. the power being developed in six cylinders, operating on the four-stroke single acting cycle, with six cranks. The method of fuel admission to the cylinders is by air-blast from an engine-driven compressor, and the firing of the fuel charge is obtained by the temperature of compression. The overall dimensions in respect of one engine only are: Length, 37 ft. 9 in.; breadth, 10 ft. 6 in.; and height from the tank top to the top of fuel valves, 21 ft. The engine is bolted directly to the tank-top and the height from the centre line of the crankshaft to the top of the fuel valves is 17 ft. 10½ in.

"The salient dimensions of the port engine were measured for the Committee by the Engineer Surveyor at West Hartlepool, of Lloyd's Register of Shipping, and the following figures are averaged from the certificate given:—

Average stroke = 975·083 mm. = 38·3891 in.
„ bore = 620·000 mm. = 24·4095 in.

Fig. 20. FUEL CONSUMED PER MINUTE. SPEED AND TORQUE CURVES.

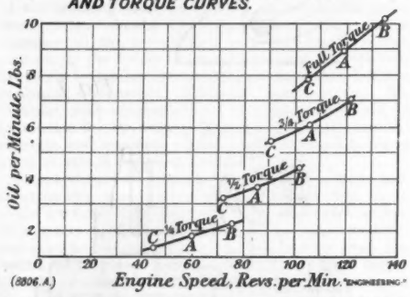


Fig. 23. FUEL PER I.H.P. PER HOUR AND PER B.H.P. PER HOUR – HORSE-POWER.

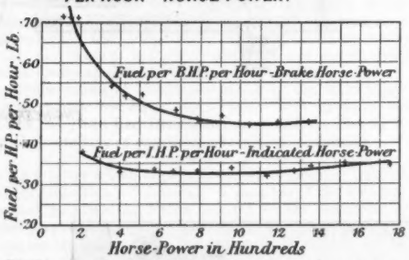


Fig. 24. THERMAL EFFICIENCY. (BOTH B.H.P. AND I.H.P. BASES) – HORSE-POWER.

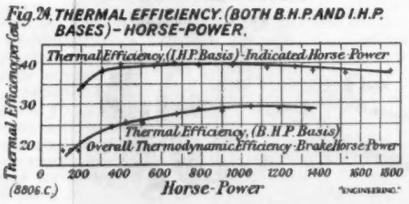


Fig. 21.

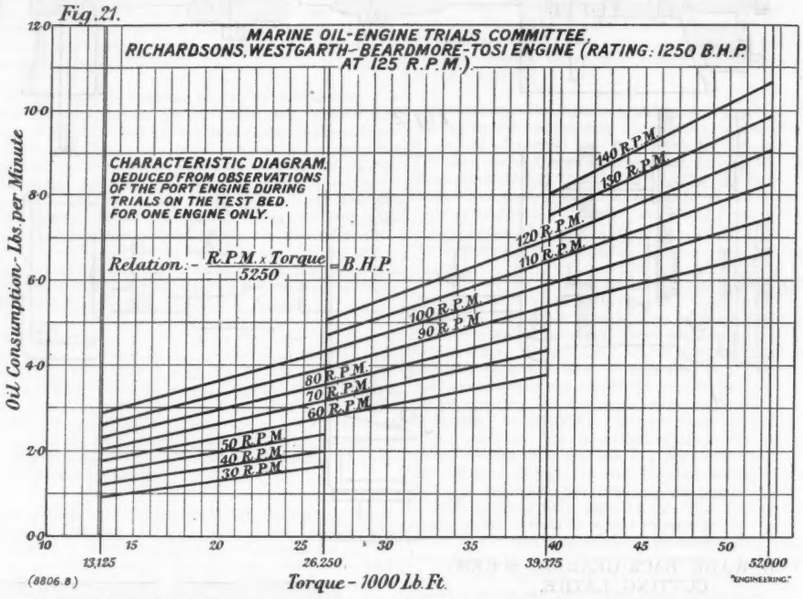


Fig. 25. MECHANICAL EFFICIENCY - MEAN EFFECTIVE PRESSURE: - (a) INDICATED. (b) BRAKE EQUIVALENT.

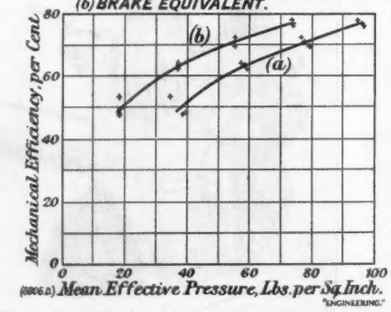


Fig. 26. BRAKE MEAN EFFECTIVE PRESSURE, OR TORQUE-MEAN INDICATED PRESSURE.

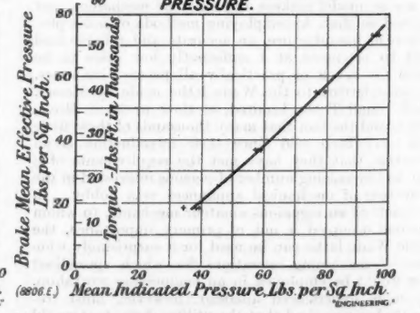


TABLE IV.—*Weight of Machinery in Engine Room.*

Part.	Weight. (Tons.)
Main engines—complete with all pipes and fittings, including thrust blocks, but excluding flywheels	426·5
Flywheels	24
Shafting and stern gear	42
Auxiliaries, pipes and fittings—	
Fuel oil system	21
Lubricating oil system	20
Starting air system	41
High-pressure air system	2·1
Exhaust system	32
Cooling water system	17
Pumping system (bilge, ballast and sanitary pumps)	18
Electric generator system	32
Steam system (boilers, condenser, oil burners, &c.	69·7
Fittings on board—Ventilators, gratings, workshop, lifting gear, tools and outfit	43·7
Spares—Main engine and auxiliaries	33
Total	822·0
Water in system	4
Water in boilers	16
Water in fresh water tank	35
Lubricating oil in system	14
Total	69·0
Total running weight	891·0

The clearance volume was given by the engine builders as 1,495·8 cub. in. and from these particulars the following constants have been calculated:—Volume swept through by each piston per stroke = 10·396 cub. ft. Ratio of compression, neglecting the late closure of the exhaust-injection valves, 13·016 in."

The report gives a complete description of the engines installed, the features of which will be familiar to our readers from accounts which have appeared from time to time in ENGINEERING. In this connection, reference may be made to the paper read before the Institution of Naval Architects by Mr. J. Richardson, in 1922 (see ENGINEERING, vol. cxiii., page 417). Drawings of a Beardmore-Tosi marine oil engine were also given in our issue of April 21, 1922 (vol. cxiii, page 488), while further details, with a description of the "director-valve" which is an essential feature of the Beardmore-Tosi design, will be found in the paper read by Professor Mellanby before the Institution of Mechanical Engineers at its meeting in Glasgow in 1923 (see ENGINEERING, vol. cxvi, page 96).

"On board ship the cooling water supplied to the main propelling engines is arranged according to the following circuits, circulation in every case being maintained by electrically-driven centrifugal pumps:—(*a*) To the jackets and exhaust manifolds and to the

air compressors, salt water supplied by a 120-ton per hour pump; (*b*) To the lubricating oil and fresh-water cooler and to the condenser, salt water supplied by a 120-ton per hour pump; (*c*) To the pistons, cylinder heads, exhaust-inlet valve cages, fresh-water supplied to both engines from a fresh-water cooler by a 90-ton per hour pump. Part of this water is withdrawn for the purpose of cooling the (ahead) cross-head guides.

"The supply of lubricant to all moving parts in the crankcase is by a steam-engine-driven reciprocating pump, the pressure of delivery being 16 lb. per square inch approximately. On board ship the lubricant falling into the crankcase flows by gravity to a drain-tank in the double bottom, from which the pump drain and passes the oil, through an oil cooler back to the engine. Sight feed lubricators supply oil to circumferential holes in the power cylinders and each stage of the air compressor.

"In order to cover all possible combinations of load and speed which the engines might be called on to develop in service, the conditions under which the

Fig. 28. FUEL PER MINUTE - INDICATED; BRAKE; COMPRESSOR; AND FRICTION HORSE-POWER.

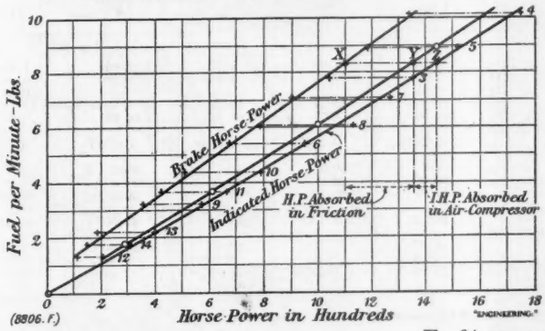
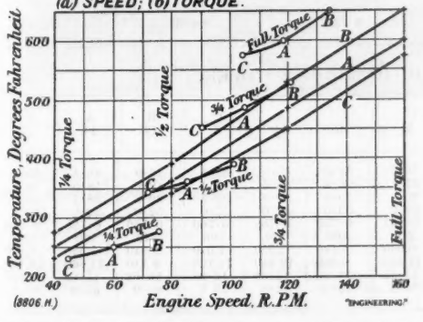


Fig. 30. AVERAGE TEMPERATURE OF EXHAUST FROM CYLINDERS, BY PYROMETER TO BASES OF (*a*) SPEED; (*b*) TORQUE.



port engine was tested ashore were arranged to imitate those at sea as closely as possible; thus, for a given depth of immersion in water of a propeller, and given slip, there is a simple approximation to propeller law, namely:—

$$\text{Torque} \propto (\text{revolutions per minute})^2 \times \text{slip},$$

which relation may be taken as correct generally. The tests ashore were accordingly carried out with the engine running against a torque corresponding to rated full power (1,250 brake horse-power at 120 r.p.m.), and at three-quarters, one-half, and one-quarter of the full-load torque, in each case the revolutions per minute being calculated according to the above propeller law, assuming constant slip. Further, in order to imitate the performance of the engine when propelling the ship in light draught during fine weather, and in heavily loaded draught during bad weather, additional tests were undertaken with the engine running respectively at 15 r.p.m. above and 15 r.p.m. below the speed corresponding to each torque, as calculated from the above relation.

"The following table (V) gives the torque; the load on the brake corresponding thereto; the speed calculated according to the relation — torque = constant × speed^2; and the high and low speeds for each torque. It is convenient for the purposes of reference later to allude to the three speeds corresponding to each torque as A, B, and C respectively." Exhaust Gas Analyses were found to require correction. Deductions affected by this are marked *.

"All the analyses were carried out at H.M. Fuel Research Station, Greenwich, the results of the analysis of the various samples of fuel oil being given in Table VI." To simplify calculation these were averaged.

"From this average analysis the following quantities have been calculated in respect of the consumption of 1 lb. of oil:—

		Lb.
(*a*)	Weight of CO_2 formed	3·11
(*b*)	,, steam ,,	1·10
(*c*)	Weight of oxygen required for (*a*)	2·26
(*d*)	,, ,, (*b*)	0·95
(*e*)	Theoretical total weight of air required	13·90."

Section V of the report devoted to the results of the trials is mainly composed of tabulated data and the reproduction of figures showing these in graphical form. The tables cover the general conditions governing the tests, the amount of fuel used and deductions therefrom, the absorption dynamometer data, indicator diagram results, exhaust-gas conditions, data relating to the air-blast compressor, cooling-water temperatures, atmospheric conditions, exhaust-gas analysis, mechanical and thermal efficiencies, and thermal balance sheet. "Curves connecting various sets of observations are also shown in this section. In general these may be regarded as self-explanatory. The 'characteristic diagram' (Fig. 21) of the engine (from which the torque exerted for any given fuel consumption and speed can be read off) has been derived by a simple construction from Fig. 20. In Fig. 28 the fuel consumptions in pounds per minute to bases of brake and indicated horsepower are plotted. On a horizontal line XZ on this diagram, if the length YZ be marked to represent the indicated horse-power of the air compressor, then the intercept XY represents the horse-power lost in friction in the engine, under the given condition of running. From this figure, by a simple construction, the chart of friction torque or friction effective pressure (Fig. 29) has been prepared. Pending a decision from the Committee on Tabulating the Results of Heat Engine and Boiler Trials, the thermal efficiency of the standard of comparison for these tests has been taken as 0·52; the necessary correction can be made later. The efficiency ratio, on this basis, is shown for each test in Table XVIII."

In addition to the figures referred to in the above quotation, we reproduce from the report the following:

Fig. 29. CHART SHOWING FRICTIONAL RESISTANCE OF ENGINE AT VARIOUS LOADS AND SPEEDS.

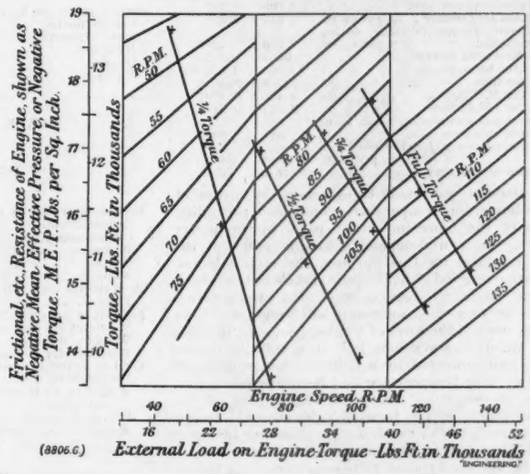

Frictional, etc., Resistance of Engine, shown as Negative Mean Effective Pressure, or Negative Torque. M.E.P. lbs. per Sq. Inch.
Torque, - Lbs. Ft. in Thousands
R.P.M.
Torque
¾ Torque
½ Torque
Full Torque
Engine Speed, R.P.M.
(8806.G.)
External Load on Engine Torque - Lbs Ft in Thousands
"ENGINEERING."

Fig. 31. TEMPERATURE OF EXHAUST GASES - FUEL PER MINUTE.

Crosses. - Average Temperature at Exit from Cylinders, by Pyrometer.
Circles. - Temperature at End of Exhaust Manifold by Mercurial Thermometer.

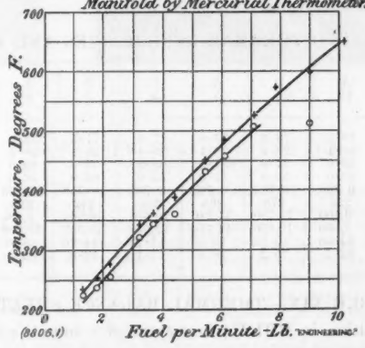


Fig. 32. CONTENTS OF EXHAUST GAS. MEAN EFFECTIVE PRESSURE (INDICATED) LB. PER Sq. In.

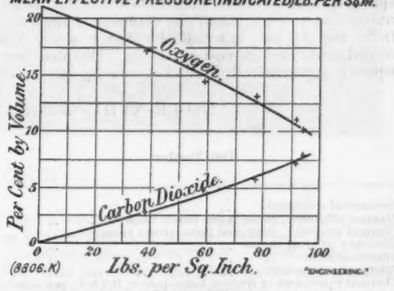


TABLE V.—(*Test Numbers 3 to 14.*)

Applied External Load.			Speed (R.P.M.).		
			A.	B.	C.
Nominal.	Torque.	Nearest Brake Load.	Calculated from Propeller Law.	High Speed.	Low Speed.
	Lb.-Ft.	Lb.			
Full torque ..	52,500	4,000	125	140	110
¾ ,, ..	39,375	3,000	108	123	93
½ ,, ..	26,250	2,000	87	102	72
¼ ,, ..	13,125	1,000	63	78	48

TABLE VI.

Test Numbers.	1 to 5	6 to 8	9 to 15
Trade description of fuel ..	Anglo-Persian Diesel Oil.		
Supplier	Wm. Cory and Son, Limited, Newcastle-on-Tyne		
Gross calorific value, B.Th.U. per lb.	19,300	19,320	19,350
Specific gravity at 60 deg. F. ..	0·8804	0·8753	0·8776
Flash point (Pensky-Martin closed test) .. deg. F.	192	185	190
Viscosity by Redwood viscometer (Admiralty pattern) No. 2—			
Seconds at 32 deg. F.	Not	Oil would	not flow.
Seconds at 70 deg. F.	carried	76	90
Seconds at 120 deg. F.	out.	42	52
Seconds at 222 deg. F.		35	38
Cold test— deg. F.	40	Similar to	43
The oil became Viscous at	37	previous	38
The oil became thick at	32	sample.	30
The oil became solid at	Trace.	Trace.	Trace.
Water content	per cent.		
Chemical analysis—			
Carbon	85·75	83·89	84·80
Hydrogen	12·27	12·43	11·95
Sulphur	0·05	—	0·11
Nitrogen	0·09	0·07	0·07
Oxygen	1·84	3·61	3·07
	100·0	100·00	100·00
Impurities	Specks	of free	carbon.
Asphaltum—	per cent.		
Soft	1·26	1·05	1·27
Hard	1·21	1·31	1·06

Fig. 23, giving curves for fuel per indicated horse-power-hour and per brake horse-power-hour plotted against horse-power; Fig. 24, thermal efficiency plotted against horse-power; Fig. 25, mechanical efficiency plotted against mean effective pressure; Fig. 26, brake mean effective pressure or torque plotted against mean indicator pressure; Fig. 30, average temperature of exhaust from cylinders plotted against speed and

torque; Fig. 31, temperature of exhaust gases plotted to fuel per minute; Fig. 32, contents of exhaust gases. The subjoined Tables XVIIA and XVIIB give data relating to the exhaust gas analysis and correspond with the curves given in Fig. 32. Tables XVIII and XIX give the mechanical and thermal efficiencies, and the thermal balance sheets.

In addition to the original programme of tests ashore, certain additional tests were made. One of these was concerned with the effect of injection-air pressure on engine performance. The conditions under which these were carried out and the results obtained are appended :—

Test.		1.	2.
Brake load	lb.	4,000	4,000
Average speed	r.p.m.	119·9	120·7
Brake horse-power		1,199	1,207
Injection air pressure	lb. per sq. in.	913	1,021
Maximum pressure (average) during combustion	lb. per sq. in.	550	549
Mean indicated pressure	" "	96·0	92·2
Indicated horse-power		1,566	1,515
Fuel per hour	lb.	522·0	519·3
Fuel per B.H.P.-hour	lb.	0·435	0·430
Fuel per I.H.P.-hour	lb.	0·334	0·342
Exhaust gas temperatures deg. F. at exit of cylinders		611	601
Thermal efficiency (I.H.P. basis)	per cent.	39·6	38·4
Mechanical efficiency	"	76·6	79·7

"An attempt was made to ascertain, by means of fusible alloys, the temperature conditions prevailing in some of the more important parts in the power cylinders. As a well-defined softening point of the alloy is essential for this purpose, the materials employed are restricted either to pure metals or to eutectic mixtures, and, in consequence, the temperature intervals between melting points are irregular. Each alloy was used in the form of a cube, $\frac{1}{4}$ in. side, inserted in a $\frac{1}{4}$ in. diameter drilled hole in a suitable carrier or plug, and indicated by a definite change of shape that its melting temperature had been exceeded.

"The investigation was made in respect of the following points in the forward cylinder: (1) In the piston, in each of the two holes provided for lifting, a screwed plug carried four alloys at a depth of $\frac{1}{2}$ in. below the surface exposed to combustion. (2) In one of the exhaust-inlet valve heads, four screwed plugs each carried one alloy at a depth of $\frac{1}{4}$ in. from the exposed surface. The plugs were symmetrically arranged on a circle of half the diameter of the valve. (3) In one of the exhaust-inlet valve seats, four screwed plugs each carried one alloy. The plugs were disposed symmetrically round the seat, and their position was midway between the shoulder forming the pressure joint and the working edge of the seat.

"The alloys were inserted in place in the evening of July 6, and were removed in the evening of July 12; the temperatures recorded therefore represent the conditions prevailing during the 6-hour trial at full power, and are as follows :—

1. Piston Crown .. .. Above 446, below 626° F.
2. Exhaust-inlet valve head " 778, " 960° F.
3. Exhaust-inlet valve seat ? " 626° F.

"None of the materials inserted in the valve seat attained a melting temperature, as similar conditions to those expected to obtain in the valve head were provided for; however, the result, though incomplete, is sufficient to show the relatively low temperature of the seat.

"The determination of the mechanical efficiency by the brake method was carried out at the completion of the long run at full power. The fuel supply to each cylinder in turn was cut off, and the brake load on each occasion was immediately reduced so that the speed remained normal, other conditions being kept as nearly constant as possible. The injection-air to an inoperative cylinder was untouched, in order to avoid the influence that a change in the blast regulation would have on the working cylinders. All readings were completed with a minimum of delay, as it was found that the friction appeared to increase when time allowed a cut-out cylinder to cool. In deducing the mechanical efficiency of the engine from this test, it is assumed that the amount by which the mean effective pressure (brake basis) is reduced when a particular cylinder is cut out of action equals the mean indicated pressure which would normally be developed in that cylinder, assuming that the frictional losses therein remain as before cutting off the fuel supply. Thus :—Mean indicated pressure normally developed in the cylinder cut out—

$$= \text{Reduction of brake mean effective pressure.}$$
$$= \frac{\text{Reduction of brake load}}{\text{Brake constant} \times \text{cylinder constant}}$$
$$= \frac{\text{Reduction of brake load}}{400 \times 0{\cdot}0227}$$

"The general conditions (full power) under which

TABLE XVIIA.—EXHAUST GAS ANALYSES AS ORIGINALLY DETERMINED.

Test Number and Group.		15 Full Torque.	5 Full Torque.	7 Three-quarter Torque.	9 Half Torque.	14 Quarter Torque.
Analysis of dry gas by volume :—						
Carbon dioxide	CO_2	4·15	4·89	3·45	2·45	1·44
Carbon monoxide	CO	0·08	0·05	0·12	0·09	0·09
Hydrogen	H_2	0·01	—	—	—	0·07
Oxygen	O_2	11·89	10·53	13·36	14·73	17·32
Nitrogen	N_2	83·87	84·53	83·07	82·73	81·08

TABLE XVIIB.—EXHAUST GAS ANALYSES AFTER ADJUSTMENT, AND DEDUCTIONS.*

Test Number.		15	5	7	9	14
Analysis of dry gas by volume :—						
Carbon dioxide	CO_2	7·25	8·00	5·77	4·80	2·75
Carbon monoxide	CO	0·08	0·05	0·12	0·09	0·09
Hydrogen	H_2	0·01	—	—	—	0·07
Oxygen	O_2	11·16	10·21	13·09	14·43	17·11
Nitrogen	N_2	81·50	81·74	81·02	80·68	79·98
Mean specific heat of dry gas B.Th.U. per lb. per 1 deg. F.		0·2364	0·2349	0·2348	0·2333	0·2337
For 1 lb. of carbon in fuel :—						
Weight of dry exhaust gas		34·7	30·7	41·7	50·0	85·4
Weight of dry gas + steam generated		36·0	32·0	43·0	51·3	86·7
Weight of dry air induced		34·82	30·82	41·82	50·12	85·52
For 1 lb. of fuel consumed :—						
Weight of dry air induced		29·52	26·13	35·47	42·50	72·52
Weight of air in excess of that required for combustion		15·62	12·23	21·57	28·60	58·62
Weight of moisture in induced air		0·34	0·29	0·37	0·44	0·78
Weight of atmospheric air induced		29·86	26·42	35·84	42·94	73·30

The mean specific heats of the dry exhaust gas, for the remaining tests, are given below :—

Test Number.	4	3	8	6	10	11	13	12
*Mean specific heat	0·2363	0·2349	0·2349	0·2337	0·2338	0·2338	0·2337	0·2337

TABLE XVIII.—MECHANICAL AND THERMAL EFFICIENCIES AND FRICTION HORSE-POWER.

Test Number	A 15	B 4	A 5	C 3	B 7	A 8	C 6	B 10	A 11	C 9	B 13	A 14	C 12
Mechanical efficiency	79·8	76·6	77·8	77·0	71·5	73·2	71·0	64·0	63·9	62·4	46·9	48·4	53·4
Thermal efficiency, brake horse-power basis	31·1	28·9	29·1	29·4	28·1	28·4	27·4	25·3	25·4	24·4	18·6	18·5	18·6
Thermal efficiency, indicated horse-power basis	38·9	37·9	37·5	38·2	39·4	39·0	39·6	39·6	39·9	39·5	39·8	38·4	34·6
Efficiency of ideal engine	52·0	52·0	52·0	52·0	52·0	52·0	52·0	52·0	52·0	52·0	52·0	52·0	52·0
Efficiency ratio	0·748	0·729	0·722	0·735	0·758	0·750	0·762	0·762	0·768	0·760	0·766	0·738	0·666
Friction horse-power	224	278	265	252	242	226	213	192	178	166	140	130	114
Thermal equivalent of friction horse-power, B.Th.U. per minute	9,500	11,780	11,240	10,680	10,260	9,580	9,040	8,140	7,550	7,040	5,940	5,520	4,830
Friction, equivalent torque, pound-feet	9,560	10,870	11,710	12,650	10,500	11,280	12,330	9,950	10,940	12,120	9,740	11,360	13,400
Friction, equivalent M.E.P. pounds per square inch	13·36	15·22	16·39	17·72	14·70	15·80	17·25	13·93	15·33	16·98	13·63	15·89	18·77
*Volumetric efficiency, per cent.	82·5	79·2	78·5	77·1	82·8	82·0	85·0	73·0	72·6	75·2	84·0	85·0	85·0

TABLE XIX.—THERMAL BALANCE SHEETS.

(All quantities, in B.Th.U., in respect of 1 minute's duration.)

Test Number	A 15	B 4	A 5	C 3	B 7	A 8	C 6	B 10	A 11	C 9	B 13	A 14	C 12
To heat carried in by fuel (gross)	168,600	196,600	173,000	151,000	137,000	117,600	105,000	85,000	71,200	62,400	43,000	34,400	25,600
By thermal equivalent of—													
Brake horse-power	52,220	56,900	50,400	44,400	38,500	33,430	28,740	21,500	18,100	15,220	8,020	6,360	4,750
Compressor horse-power	3,660	4,720	4,050	3,020	3,840	3,155	2,700	2,850	2,410	2,020	1,600	1,280	875
Friction horse-power	9,500	11,780	11,240	10,680	10,260	9,580	9,040	8,140	7,550	7,040	5,940	5,520	4,830
By heat rejected to—													
Jackets	18,400	21,040	18,250	19,900	14,100	14,870	15,150	10,790	†	10,550	6,380	6,840	†
Manifold	17,100	19,600	17,950	15,230	12,890	7,580	11,150	8,055	—	2,945	2,710	2,575	nil
Heads	20,700	22,920	21,220	19,540	16,210	14,650	12,950	9,900	8,610	7,165	4,080	3,700	3,490
Pistons	5,500	6,920	6,320	6,040	4,810	4,920	5,260	4,370	8,120	4,200	2,740	2,610	nil
A.C. jackets and coolers	4,080	5,140	4,670	3,860	4,440	3,840	3,760	3,180	6,340	2,790	1,990	1,890	1,590
*By heat in dry exhaust gas + *By total heat of superheated steam	41,688	47,032	37,982	30,843	32,922	25,700	24,041	16,066	13,378	11,449	9,440	6,906	3,843
By radiation and unaccounted for	−4,248	+548	+918	−2,513	−972	−125	−7,791	+149	—	−979	+100	−3,281	—
Total	168,600	196,600	173,000	151,000	137,000	117,600	105,000	85,000	71,200	62,400	43,000	34,400	25,600

† The water quantities in these cases, as recorded, are inadmissible.

PORTABLE STEAM-DRIVEN AIR COMPRESSOR.

CONSTRUCTED BY MESSRS. MERRYWEATHER AND SONS, LIMITED, ENGINEERS, GREENWICH.

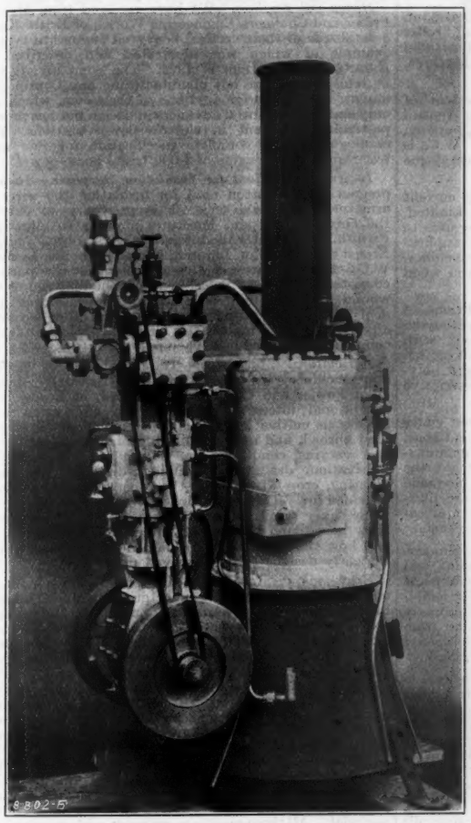


FIG. 1.

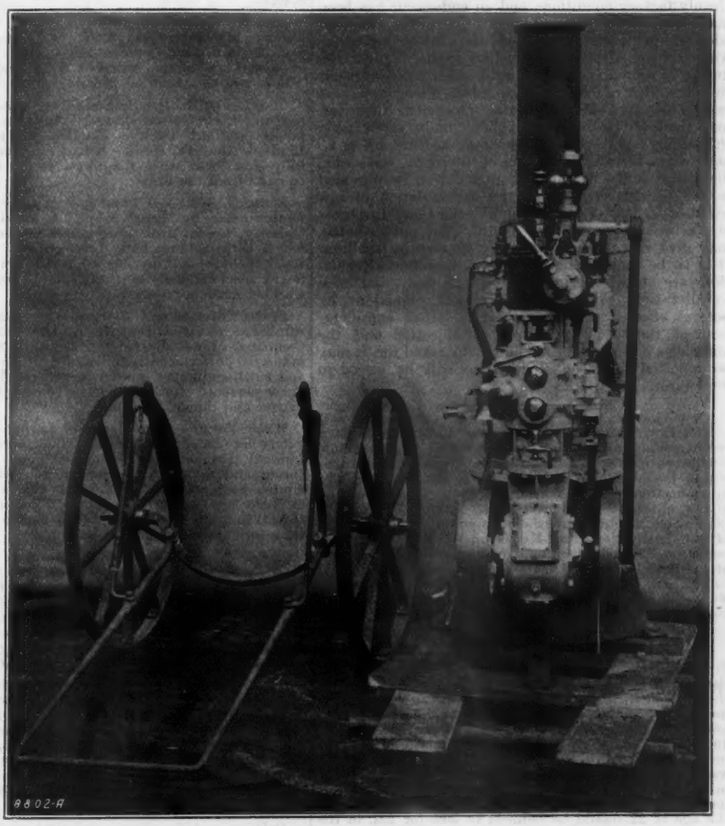


FIG. 2.

the test was carried out are as follows, and the observations made are given in Table XX :—

Engine speed by tachometer	122 r.p.m.
Injection-air pressure	1,000 lb. per sq. in.
Fuel notch	23·2
Brake load	4,000 lb.
Brake M.E.P.	73·5 lb. per sq. in.

"The mechanical efficiency is therefore—

$$= \frac{73 \cdot 5}{99 \cdot 0} = 74 \cdot 2 \text{ per cent.}$$

"The mean indicated pressures calculated by this method differ from those obtained from cards, but the test may be regarded as a useful check. It should be noticed that no corrections to M.I.P. either for injection-air or for pumping have been attempted."

TABLE XX.

Cylinder cut out.	Net Load Carried at Brake.	Reduction in Load from Normal.	Reduction in Brake M.E.P. = M.I.P.
	lb.	lb.	lb. per sq. in.
1, forward	3,100	900	99·2
2 ,, ...	3,075	925	102·0
3 ,, ...	3,075	925	102·0
4 ,, ...	3,140	860	94·8
5 ,, ...	3,120	880	97·0
6, aft	3,100	900	99·2
Average mean	indicated	pressure ..	99·0

With regard to lubrication of the power cylinders and air compressors, the report states :—"The six power cylinders were supplied by two force-feed lubricators and a similar lubricator supplied the three air-compressor cylinders, the drive in each case being from an oscillating shaft on the engine ; the oil supply was therefore proportional to the engine speed. From records taken in each of the longer tests the consumption at 120 r.p.m. was :—

For the power cylinders	3·1 gallons per day.
For the air compressor	1·5 gallons per day."

(To be continued.)

PORTABLE STEAM-DRIVEN AIR COMPRESSOR.

THE "Valiant" steam pump, one of the specialities of Messrs. Merryweather and Sons, Limited, Greenwich, has long been recognised as a standard portable high-pressure water-raising machine. The firm have recently introduced a novel form of steam-driven air compressor and boiler combined, the engine of which is built on the same lines as the "Valiant" water pump. We illustrate the "Valiant" air compressor in the views, Figs. 1 and 2, on the present page.

The boiler is of the Merryweather vertical water-tube type. The firebox is designed for burning wood or coal, and can be conveniently adapted for burning oil fuel if desired. The boiler tubes are of copper, access to the whole of which, for examination or replacement, can be obtained by removal of the shell. Steam can be raised to working pressure, 120 lb. per square inch, in from 10 minutes to 15 minutes.

The air-compressor is of the single-cylinder direct-acting type, and is mounted in line with and below the steam engine which drives it. It is capable of maintaining continuously an output of 40 cub. ft. of air per minute at a pressure of 100 lb. per square inch. The engine will give 10 brake horse-power from the crankshaft when the air compressor is running free from load. The steam and air-compressing cylinders are connected together by a cast-iron distance piece, the steam cylinder being well placed for connecting the steam and exhaust pipes to the boiler and chimney.

The air-compressing cylinder is of cast-iron, with a cast-iron piston and steel piston rings. The valves are of gun-metal, with metal seatings, all readily accessible through a cover over each pair of valves. The air-compressing cylinder and valve chambers are water jacketed, the cooling water being used for feeding the boiler ; it is circulated by a feed pump driven by an eccentric, a tail rod from the pump operating the engine slide valve.

The crankshaft runs in ball bearings in a totally enclosed casing attached to the lower end of the air-compressing cylinder by a cast-iron distance piece forming a guide for the crosshead. Flywheels are fitted at each end of the crankshaft, one of which has a wide face and can be used as a belt pulley. A centrifugal governor is fitted controlling the steam inlet. Gun-metal sight-feed lubricators are provided for both the engine and compressor.

For rock boring work underground, sufficient compressed air is available for driving a single powerful jack hammer drill, whilst if boring is required in the open sufficient steam can be supplied from the boiler direct to two jack hammers simultaneously. By taking power by belt from the flywheel, the machine may also be used for a variety of purposes, such as sawing, driving a stamp battery, a dynamo, a pump or any auxiliary machinery. The total net weight of the boiler and engine is about 15 cwt. The parts can be readily dismantled for up-country transport if necessary, in which case the heaviest portion is the boiler firebox, weighing about 4½ cwt. There is a ready demand for this machine in places where compressed air is necessary, and where portability is of prime importance.

REGULATIONS FOR ELECTRIC ACCUMULATOR MANUFACTURE.

NOTWITHSTANDING the operation for many years of Regulations relating to the manufacture and repair of electric accumulators, the incidence of lead poisoning among workers engaged in this industry has continued high. A comprehensive inquiry into the matter has recently been undertaken by Dr. Bridge and Mr. Price, two of H.M. Inspectors of Factories, and at a conference held in March between a committee comprising employers, operatives and the above-named gentlemen, amendments to existing regulations were advocated. Certain proposals were agreed to, and these have been embodied in a draft, copies of which may be obtained on application to the Factory Department, Home Office, London, S.W. 1.

The principal alterations in the existing code include the extension of the Regulations to cover works in which accumulators are repaired only. It is felt that

certain similar conditions exist in these latter establishments to those obtaining in manufacturing works, but it is noteworthy that observance of only those sections of the rules specifically dealing with such conditions is stipulated in repair processes. A further alteration relates to exhaust ventilation and the maintenance of cleanly factory conditions, and an endeavour has been made to bring the requirements up to the standard adopted in recent regulations for other industries where danger of poisoning by lead exists. Under the duties of works' occupiers is included the statement that the floor of every room in which a lead process is carried on shall be smooth and impervious to water, and shall be cleansed throughout daily after being thoroughly sprayed with water at a time when no other work is being carried on in the room. One rule, viz.: that sufficient bath accommodation be provided for all persons engaged in the manipulation of raw oxide of lead or of pasting, unless the Chief Inspector of Factories approves the use of local public baths, may give rise to some difficulty in certain localities. It is to be remembered, of course, that these Regulations are at present in proposal form only, and open to alteration. The date for lodging objections by persons affected was November 16. After consideration of the specific grounds of objection and the omissions, additions, or modifications asked for, it may be expected that the Regulations will be issued in final form.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—At a recent council meeting of the Institution of Automobile Engineers it was unanimously decided that the Institution medal should be awarded to Dr. R. Ormandy in connection with the editing, checking and preparation of the matter for the report of the Empire Motor Fuels Committee, recently published as a volume of Proceedings of the Institution; to Mr. Geo. W. Watson for his paper on "Standardisation," which formed the subject of his presidential address before the Institution; and to Mr. H. G. Burford for his services in connection with the co-ordination of the relations between the Institution, the S.M.M.T. and the B.E.S.A.

THE JUNIOR INSTITUTION OF ENGINEERS.—ANNUAL SUBSCRIPTION: An extraordinary general meeting of the Junior Institution of Engineers was held on Friday, the 14th inst., to consider the reduction in subscription for junior members of the Institution. At present an associate member, who may be between the ages of 19 and 26, has to pay an annual subscription of 37*s.* (or 30*s.* in the provinces). The Council felt that this was too big a sum for a young man to be asked to pay in the early days of his training, and consequently put forward a resolution that the subscription for those under the age of 22 should be reduced to 30*s.* (or 25*s.* in the provinces), the subscription for those above that age being the same as it is at present. The resolution was very favourably received and was passed almost unanimously.

THE UNIVERSITY OF LONDON.—Fifteen Entrance Scholarships and Exhibitions are available for award to students entering University College, London, in October, 1925. Three of them are tenable in any of the five College Faculties—arts, laws, science, engineering, medical sciences, or in the School of Architecture. Two of them are tenable in the Faculty of Arts only, one in the Faculty of Science, one in the Faculty of Engineering, one in the Faculty of Law, three in the Faculty of Medical Sciences, two in the School of Architecture, and one in the School of Librarianship. Most of the scholarships and exhibitions are of the value of 40*l.* a year for three years, but the value of any scholarship or exhibition may be increased by the grant of a supplementary bursary if the circumstances of the scholar or exhibitioner make such a grant necessary.

PRIZE FOR VENTILATION SCHEME.—Several of the ancient Livery Companies, as our readers are doubtless aware, have made it a regular practice to endeavour to further the interests of the particular industry they represent by offering prizes, scholarships and other awards for annual competition. The Worshipful Company of Fanmakers is a case in point. This company, which was originally concerned with that class of hand-operated fan in which attractive appearance was of far greater importance than was aerodynamic efficiency, has extended its activities within recent years to include the type of power-driven technical fans with which engineers are more directly interested in their professional capacities. With a view to promoting the study or modern methods of ventilation, the company has decided to institute an annual competition and to award a silver medal for the best essay submitted on some branch of this subject. For the 1924-25 competition the subject selected is "The Ventilation of a Police Court" measuring 44 ft. by 38 ft. in plan and 42 ft. high, free on all sides, and provided with the necessary administration, waiting and sanitary accommodation, as far as these may affect the ventilation scheme. The assessors, it is understood, will attach particular importance to originality, and to any evidence of research work carried out by competitors. The latter must be of British nationality, and not over 25 years of age, while the essays must be received on or before May 1, 1925. Further particulars can be obtained from the Clerk to the Fanmakers' Company, 62, London Wall, London, E.C. 2.

CATALOGUES.

Steelwork.—Circulars illustrating steel framed buildings, colliery tubs, steel hand tip-carts and steel wheelbarrows are to hand from the Ransome Machinery Company, Limited, 14, Grosvenor-gardens, London, S.W.1.

Laundry Machinery.—Various types of Decoudun ironing machines, comprising a felt-padded roller working in a concave steam-heated bed, are illustrated in a sheet catalogue received from Messrs. Manlove, Alliott and Co., Limited, Nottingham.

Closed Feed-Water System.—The closed system of feed-water circulation designed and made for central power stations by the English Electric Company, Limited, Queen's House, Kingsway, London, W.C., is fully described, with diagrams, in a new catalogue to hand from the firm.

Electric Motors.—A catalogue of alternating current motors made by Messrs. F. and A. Parkinson, Limited, Guiseley, Leeds, gives illustrations of the many uses to which these motors have been applied. The applications include the driving of small sewing machines, heavy machine tools and mill plant, hoists, and wood working machinery.

Electric Motors and Starters.—Two new editions of catalogues received from the British Thomson-Houston Company, Limited, Rugby, deal, respectively, with industrial pattern control pillars for direct-current motors and small induction motors for single-phase and polyphase current. Both catalogues contain full descriptive matter and dimension tables.

Water Valves.—A catalogue of Larner-Johnson water valves is to hand from Messrs. J. Blakeborough and Sons, Limited, Brighouse, who have acquired the manufacturing and selling rights for all countries except the United States and Canada. The valves can be made in very large sizes (some of 20 ft. diameter are illustrated) and are used on pipe lines and in other applications for controlling the flow of water on a large scale.

Railway Points.—Catalogues describing single-plunger, catch-handle locking apparatus, an electric point and lock machine, with separate detection for each point tongue, and a system of electric point detection for enabling the signalman to ascertain that the points are properly set before he allows a train to pass, are to hand from the Westinghouse Brake and Saxby Signal Company, Limited, 82, York-road, King's Cross, London, N.W.

Oil Engines.—A two-cycle, cold-starting, heavy-oil engine with airless injection of fuel, known as the Polar engine, is well illustrated and described in a catalogue received from the Atlas Diesel Engine Company, Limited, a Swedish firm with a London office at 35, Surrey-street, Strand, W.C. 2. The engines are of the vertical type, developing from 35 h.p. to 50 h.p. per cylinder, and are made with one or two cylinders, according to requirements.

Lubricating Oils.—Two catalogues of lubricating oils have reached us from Messrs. Sterns Limited, Royal London House, Finsbury-square, E.C.2. One of these catalogues describes the conditions of lubrication in various types of steam turbines, specifying four oils for this purpose and a special oil for reduction gears. The other catalogue deals similarly with oil engines specifying oils for six different types. Both contain explanatory matter of special interest to engineers.

Stone-Dusting Machine.—A machine mounted on four wheels for distributing stone dust in colliery workings is the subject of a special catalogue issued by Messrs. Oldham and Son, Limited, Denton, Manchester. The object of the operation of stone dusting is to keep down the inflammable coal dust, and an important point in the design of machines for the purpose is to make them convenient to work in the limited space available and under the awkward conditions existing in mines.

Magnetic Brakes for Tramway Cars.—The tramway-car magnetic brake is one of those widely-used pieces of mechanism which by its almost infallible efficiency ceases to attract attention. A descriptive catalogue of these brakes, received from the Metropolitan-Vickers Electrical Company, Limited, of Manchester, is interesting in that it shows how carefully design and workmanship are attended to, and how accurately the system can be adapted to the various types of truck employed on tramway cars.

Internal Combustion Engine-driven Machinery.—A considerable number of units comprising an oil or petrol engine coupled to a machine and mounted in a frame are illustrated in a special catalogue received from The Parsons Motor Company, Limited, Southampton. The machines include electric generators, welding plants, pumps, fire-engines, air compressors, winches, stone crushers, &c., and the frames are arranged for portable, semi-portable and fixed operation. Approximate prices are stated in each case.

Copper Pipes.—The Yorkshire Copper Works, Limited, Leeds, have issued a number of circulars dealing with the use of copper pipes for hot-water services and other purposes in domestic and public buildings. These pipes are drawn from the solid and tested to a high pressure. The makers claim that they do not gather incrustation and that, in many cases, they are cheaper than lead or iron pipes. There are now on the market several kinds of fittings and simple tools by which connections can be made without screwing.

Condensers.—The Mirrlees Watson Company, Limited, Scotland-street, Glasgow, have sent us a list of condensing plants which they have installed at home and abroad, illustrating examples of the various types. The surface condensers range in capacity from 720 lb. to 220,000 lb. of steam per hour and cover practically all requirements for land service; a few examples of marine practice are also included. The jet condensers listed are also very numerous, and include many of large capacity. The particulars given are necessarily brief, but are nevertheless of considerable interest.

Heavy Oil Engines.—We have received from Messrs. Fraser and Chalmers Engineering Works, of Erith, Kent, a catalogue of their vertical heavy oil engines, a typical example of which was illustrated and described in ENGINEERING of June 6, 1924. The company, it will be remembered, are not manufacturing any Continental design, but have originated one of their own, which not only embodies essential advances in design but has proved particularly efficient in electric power stations. The catalogue gives a complete specification together with test results of an engine of 1,000 brake horse-power.

Impregnating Plant for Insulation Purposes.—In impregnating the cotton used for insulating the wires of armatures and field coils, it is necessary to extract the entrained air and moisture in order to allow the varnish, &c., to enter the interstices of the fibre. Messrs. Ernest Scott and Co., Limited, Kingsway-house, London, W.C.2, have sent us a catalogue of plant for this purpose consisting of a closed vessel in which the material or the wound armature may be placed. The catalogue also deals with pumps, condensers, mixers, and other necessary auxiliaries. The material is dried and the insulating compound admitted in a vacuum.

Agricultural Machinery.—The catalogue of engines and machinery for agricultural work issued by Messrs. John Fowler and Co. (Leeds), Limited, of Leeds, is of exceptional interest, particularly in connection with large-scale cultivation. This firm's machinery is largely used abroad, and many highly ingenious applications to suit varying conditions are shown in the catalogue. Cultivation, draining, reclaiming, ditching, trenching, planting, crop-lifting, and other operations are all fully provided for. The illustrations given, comparing engines made sixty years ago with those of the present day, show how sound the late Mr. John Fowler's ideas were and how the progress in mechanical science has enabled the early designs to be improved upon.

Brick-making Machinery.—The principal machines for making bricks, including runner grinding mills, screens, mixers, vertical and horizontal pug mills, and presses, are dealt with in a catalogue from Messrs. Clayton, Goodfellow and Co., Ltd., of Blackburn. The presses have an output of 500 to 600 "repress" bricks per hour; that is, bricks which have received a second pressing in the mould, the second pressing producing a smooth solid facing on the bricks. "Double mould" machines dealt with in the catalogue, produce 950 to 1,000 bricks per hour. These machines work semi-plastic material and require from 6 to 8 horse-power for driving. Another machine for plastic material, having crushing rolls, mould, cutting-off table and hauling gear, and requiring 30 to 40 horse-power, will turn out 10,000 to 20,000 bricks per day, the production depending upon the nature of the material. All these machines are made with standardised replaceable parts, which are kept in stock for prompt delivery.

Agricultural Implements and Machines.—The catalogue issued by Messrs. James and Frederick Howard, Limited, Bedford, deals mainly with the implements and machines required in farming, including land cultivation and subsequent operations. The pages illustrating the various ploughs, harrows and other machines are of great interest as an indication of the wide range of appliances that are made to suit the soils and conditions of various countries. They also show the good use made of opportunities for mechanical ingenuity, even when improvements are limited by the draught powers of horses and oxen. Steam engines, motor tractors and cable-ploughing equipment are well represented in the catalogue. One section of the catalogue is devoted to abattoir equipment and another section deals with many convenient forms of presses for operation by hand, electric-motor and hydraulic power. Light railway material forms the subject of the remaining section, which shows some ingenious tubs and wagons in addition to all the standard forms of rails, wagons, locomotives and tracks. The catalogue extends to 128 quarto pages and should prove helpful in securing foreign trade as well as in meeting home requirements.

FRENCH MERCHANDISE MARKS REGULATIONS.—The French *Bulletin Douanier*, of October 17, 1924, publishes some rulings under the heading "Instructions et Décisions," which have now been adopted by the Authorities, concerning the application of Article 15 of the Law of January 11, 1892. According to the terms of that Article, foreign goods, natural or manufactured, which bear either on the packing or on the goods themselves a trade mark, a sign, or any indication whatsoever likely to cause the impression that the goods have been made in France or are of French origin, can only be imported into France if the trade mark, sign or indication in question is followed by a correction phase in the French language—"importe de" or "fabrique en"—followed in each case by the name of the country of import or manufacture. One of the new decisions, a translation of which is appended, will be of interest to engineers engaged in export trade to France:—"When bearing the name of a manufacturer established in France, accessories or elements for manufacture, such as wheel caps, gauges, or safety apparatus for boilers, which can be sold separately, must bear the corrective phrase in an apparent manner. The only exception to this obligation are articles imported by manufacturers who intend to incorporate the same in machines or apparatus constructed by them."

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.

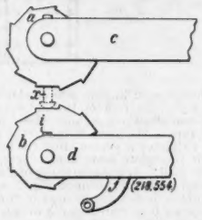
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

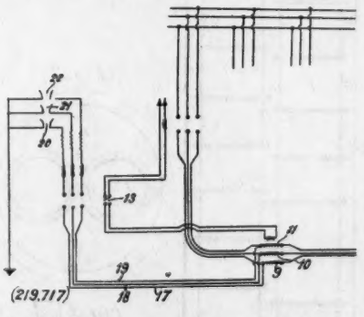
ELECTRICAL APPARATUS.

218,554. C. A. Hadley, Inverness, and The Rose Street Foundry and Engineering Co., Limited, Inverness. Electric Welding Apparatus. (4 *Figs.*) November 19, 1923.—The invention relates to machines for heating metal rivets of the kind in which the rivets are placed between two contact blocks or electrodes through which electric current is passed. The electrode is preferably in the form of a disc of hard-rolled copper, the periphery of which is eccentric to a pivot on which it can be turned and around which on each side is a face by which the disc is clamped between the two arms of a fork having corresponding faces contacting with those on the disc and so that a bolt passed through the arms and through the disc between them may serve as a pivot and also as a means for clamping the disc



at any required position. The faces on the discs are concentric with the axis of rotation, and are thus always in intimate contact with the faces on the forked arms so as to convey effectively the electric current, and since no part of these surfaces become exposed when revolving the electrodes to a new position, good electrical contact is always assured. The drawing shows two similar discs *a* and *b* pivotally mounted on arms *c* and *d*. A rivet is shown at *x*. The discs are shown of stepped form, and on each side is a flat face adapted to contact with like faces on the arms *c* and *d*. A bolt is passed through the fork of the arms and a hole in the disc, and has a nut by which the arms can be tightly pressed upon the disc, thus ensuring good electrical contact. A stub screw to hold the bolt is shown at *i*, and the usual connection for the pedal link is shown at *j*. (*Sealed.*)

219,717. Switchgear and Cowans, Limited, Old Trafford, Manchester, and G. H. Neep, Old Trafford, Manchester. Protective Arrangements for Electric Distribution Systems. (5 *Figs.*) February 27, 1923.—The invention has reference to electrical distribution systems in which all the conductors are normally insulated from earth. According to the invention, in distributing systems in which all of the conductors are normally insulated from earth, there is employed in con-



junction with the conductors, windings 9, 10, 11 which normally produce balanced forces upon a relay 13 or other device and a tapping 17, 18 or 19 is taken from each conductor of the cable to one side of a spark gap 20, 21 or 22 or other suitable automatic earthing device operated electrostatically, the opposite side of which is connected to earth, and which in the event of a fault in the insulation arising on the cable operates under the difference of potential to which it is subjected, thus providing a return path for the leakage current. (*Sealed.*)

GAS ENGINES, PRODUCERS, HOLDERS, &c.

219,179. Armstrong Siddeley Motors, Limited, Coventry, F. R. Smith, Coventry, and B. W. Shilson, Coventry. Air Brake Dynamometer Engine Power-Testing Mechanism. (2 *Figs.*) August 1, 1923.—The invention relates to air brake dynamometer engine power-testing mechanism of the kind in which the air brake is enclosed in a casing and the air delivered from the casing is directed upon either the engine or a radiator for cooling purposes, and wherein there is located inside the casing a ring of blades, each separately pivoted, the positions of which are adjustable about their pivots to vary the power absorbed. The casing is shown at A and part of one of the rotating paddles of the fan at B, the air, in addition to travelling round inside the casing, flowing in the direction of the arrows in Fig. 2. Concentrically arranged around the fan is a ring of blades C, which are balanced about their pivots D and are provided with arms E which are coupled together by links F. Each blade is divided into two parts C, C2, and the left-hand blade parts are all interconnected by the links F so that they are all simultaneously controlled, and the same applies to the right-hand blade parts C2 which have arms E2 and links F2. Thus at low speeds both of all sets of blade parts may be open, so that the

Fig. 1.

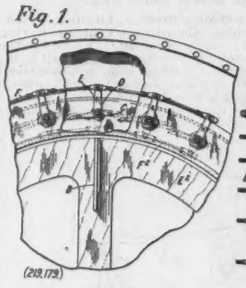
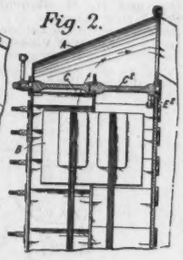
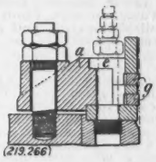


Fig. 2.



required power is absorbed and yet the air delivery is very much greater than usual, and satisfactory cooling and just the desired air flow can be obtained. (*Sealed.*)

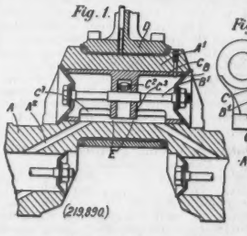
219,266. Palmers Shipbuilding and Iron Company, Limited, Hebburn-on-Tyne, and D. Kemp, Hebburn-on-Tyne. Internal Combustion Engines. (4 *Figs.*) May 10, 1924.—The invention has particular reference to cylinder liners of the kind usually fitted to engines of the opposed-piston type and provided with detachable extensions fitted with scraper rings. According to the invention, the cylinder liner extension



a is provided with a separate junk ring *e* containing the scraper rings *g* which junk ring can be readily removed to allow the removal of the scraper rings when it is desired to fit or remove the piston. A guide ring is also provided and is adapted to be inserted in the place of the junk ring and scraper rings to permit the free entry of the piston rings, said guide ring being subsequently removed and the scraper and junk rings replaced in position. (*Sealed.*)

219,890. D. Napier and Son, Limited, Acton Vale, London, and G. S. Wilkinson, Acton Vale, London. Lubrication of Bearings. (2 *Figs.*) February 18, 1924.—The invention relates to the lubrication of crank-pins eccentrically mounted on a rotatable shaft. The hollow crankshaft A is provided with a hollow crank-pin A1 form integral with it. The open ends of the crank-pin are closed by conical end caps B held in position by a tension rod B1. The hollow crank-pin in conjunction with the end caps B constitutes a chamber communicating with the bore of the crankshaft by passages A2 formed in the crank-webs. Mounted within this chamber is a hollow sleeve C having a longitudinal slot C1 extending along that wall of the sleeve which lies adjacent to the ends of the ducts A2, thus establishing communication between the interior of the chamber in the crank-pin and the passages in both crank-webs. Formed in the circumferential wall of the sleeve C at, say, about 130 deg. from the slot C1 is an oil delivery passage C2 which communicates with an oil delivery duct A3 in the crank-pin leading to the bearing surface for the connecting

Fig. 1.



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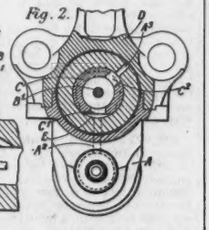
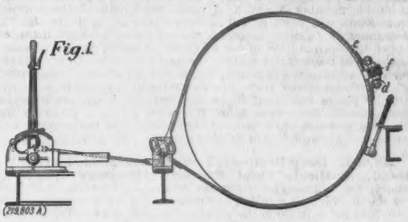


rod D. On either side of the oil delivery duct C2 is a partition or baffle C3 preferably formed integral with the sleeve C and extending transversely across the chamber so as to leave only the passage E which serves to establish communication between the oil ducts A2 in both crank-webs. The operation of the device is as follows. Oil is delivered to the interior of the crank-pin through one of the ducts A2 from the hollow crankshaft and enters the chamber between one of the partitions C3 and its adjacent end cap B. Any solid particles or other impurities which the oil may contain are separated and deposited by the centrifugal force due to the rotation of the crankshaft against the inner circumferential wall of the sleeve C. Hence the oil which passes to the delivery ducts C2, A3 is freed from solid particles before it enters the space between the partitions C3 forming an intermediate chamber between the separating chambers and the oil delivery ducts. In this way the oil delivery duct or ducts can be placed in the best theoretical position for lubricating purposes without any fear of them becoming clogged or filled with sludge carried by the oil. (*Sealed.*)

LIFTING AND HAULING APPLIANCES.

219,803. M. B. Wild and Co., Limited, Nechells, Birmingham, and M. B. Wild, Erdington, Birmingham. (4 *Figs.*) July 5, 1923.—The invention relates to friction brakes of the drum and flexible band type employed upon hauling, winding and like machinery. The invention comprises the arrangement in combination with the bolt connecting the ears or like extremities of the brake band, of a plurality of pivoted distance pieces, one or more of which can be swung into or out of the service position between said ears or extremities as may be required. The distance pieces *a* consist of plates and all of them (excepting that denoted by *a*1) have a gap or aperture *b* such as to permit of its being passed laterally into or out of engagement with or position upon the bolt *c* connecting the adjacent ears *d* or extremities of the brake band *e*. The distance pieces may thus be inserted in or withdrawn from their service position without withdrawal or disconnection of the said bolt. Each of the said distance pieces *a* has an extended or projecting

Fig. 1.



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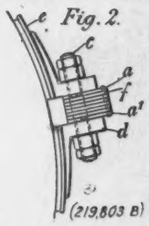


Fig. 3.

part with an aperture therethrough whereby it is mounted upon a hinge or pivot pin *f* affixed to the plate *a*1, which is threaded or passed into position on the bolt, the plate *a*1 being formed with a plain hole instead of a gap. (*Sealed.*)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

219,884. Thomas Broadbent and Sons, Limited, Huddersfield, and A. H. Weir, Huddersfield. Centrifugal Friction Clutches. (2 *Figs.*) February 2, 1924.—The invention relates to centrifugal clutches of the type wherein a series of shoes *c* carried in recesses in a "spider" or block *b* fast on a driven shaft *a* are adapted to be thrown automatically outwards under centrifugal action to engage frictionally the inner surface of a drum *d* on the shaft or part to which motion is to be conveyed. According to the invention, the boss *b*1 of the driving block *b* is provided with one or more longitudinal recesses or grooves *b*2 in which is loosely carried a non-fluid lubricant *e*, such, for instance, as graphite, which may be in the form of blocks or in granulated or powder

Fig. 1.

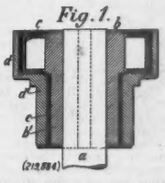
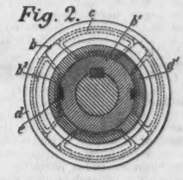


Fig. 2.



form. As the driving block commences to rotate, on starting up the clutch, the lubricant is thrown outwardly by centrifugal action into contact with the inner face of the sleeve *d*1 and provides efficient lubrication until such time as the shoes commence to drive the drum *d*, whereupon, as will be understood, the boss *b*1 and sleeve *d*1 rotate together, and no relative rotatory motion occurs between them. On stopping the clutch, the inner surface of the sleeve is lubricated immediately the shoes relinquish their frictional driving grip on the drum, and the lubrication is continued until such time as the driving member approaches so nearly a state of rest that the lubricant ceases to be thrown centrifugally outwards. (*Sealed.*)

MINING, METALLURGY AND METAL WORKING.

219,760. J. A. Duxbury, Baildon, and W. P. Butterfield, Limited, Baildon. Apparatus for Lock Forming Sheet Metal. (3 *Figs.*) May 10, 1923.—The invention relates

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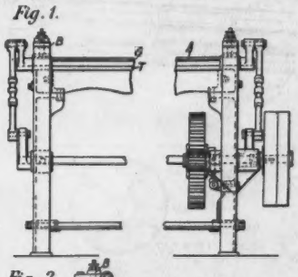


Fig. 2.

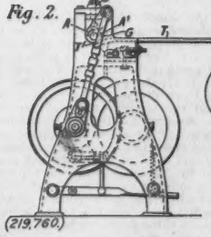
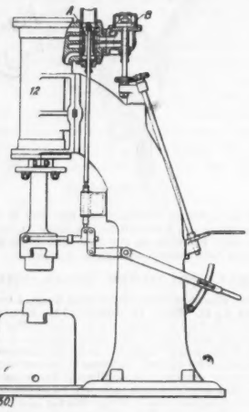


Fig. 3.

to apparatus for lock forming sheet metal. There is mounted above a table T, which has its rear edge T1 curving downwards, a turntable member A carried somewhat eccentrically on an operating shaft A1 which is oscillated to turn the member first

in one direction and then back. The turntable member A is provided with a gap G to receive the edge of the sheet to be operated upon. The shaft A^1 of the turntable member A is carried in bearings B which are adjustable. This table T is horizontal as regards its major face and projects towards the turntable member A and at a point some little distance away from same will bend or curve downwards as at T^1 in Fig. 2. Assuming the gap G is facing the operator a slight distance above the normal level of the table, the operator presses or feeds the edge of the metal sheet into the gap and causes the turntable member to turn towards him, *i.e.*, in the direction of the arrow, Fig. 2, the member turns downwards and because it is eccentrically placed will bring the sheet down with it and try to make contact with the curved table T^1 below, giving a gradually increasing pressure which not only bends the edge but also flattens same on the completion of the down stroke. (*Sealed.*)

219,050. Davy Brothers, Limited, Sheffield, and T. W. Hand, Sheffield. Fluid Pressure Hammers. (6 *Figs.*) March 16, 1923.—The invention relates to hammers actuated by elastic fluid. According to the invention, two valves A, B are provided for controlling the supply of motive fluid to the hammer cylinder 12, one of the valves A being a distribution valve for



the cylinder 12 whilst the other valve B is a combined change-over and regulator valve adapted to permit the fluid pressure to act in the hammer cylinder 12 either for single-stroke working under purely manual control or for automatic working alternatively at will, this latter valve being also adapted to regulate the rate at which motive fluid passes to the distribution valve A. (*Sealed.*)

219,787. Fisher, Humphries & Co., Limited, Pershore, and H. M. Hutchinson, Pershore. Rotary Drying Cylinders. (6 *Figs.*) June 25, 1923.—The invention has reference to rotary drying cylinders employed for drying coal, breeze, crushed clinker and similar material. The invention consists of a rotary cylinder drying apparatus having in combination a plurality of lifting members secured to the inner walls of the cylinder and a partition connected to the walls and provided with a central trough section, the partition dividing the cylinder into two separate sections, whereby an increased area of drying surface is obtained and the desired uniform and continuous showering motion of the material is effected during its passage through the drying cylinder. The rotary drying cylinder 7 is mounted so that its inlet 7*a* is higher than the outlet end 7*b*. Mounted within the fore-end of the cylinder 7 and secured to the periphery of the inner walls thereof is a plurality of equi-distantly spaced curved vanes 8 which, on the rotation of the cylinder 7, serve to feed the material introduced into the inlet thereof by the chute 9 through the cylinder. The drying part of the cylinder comprises three sections A, B, C, each of

Fig. 1.

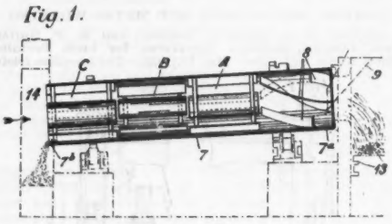
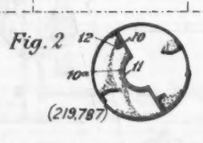


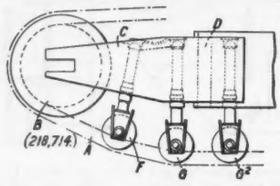
Fig. 2



which is built up of the same components differing from one another only in the relative setting or disposition of the drying surfaces. Each of these sections, A B and C is divided into two parts by a partition 10 having a semi-cylindrical section 10*a* formed in the central portion thereof within which is disposed a semi-cylindrical trough 11, the partition 10 being a diameter of the cylinder and the axis of the semi-cylindrical section 10*a* of the member 10 and the trough 11 being disposed on the axis of the cylinder. Secured to the inner periphery of the cylinder 7 are four vanes 12 set at 90 degs. apart, one pair of vanes being mounted on opposite faces of the partition 10. The operation of the apparatus is as follows: The hot gaseous combustion products from the furnace 13 are drawn through the cylinder by the draught induced by a flue 14, the cylinder being rotated meanwhile. The material to be dried is introduced into the inlet end of the cylinder 7 from the chute 9 and is then fed by the curved vanes 8 through the cylinder. The material during its progress through the cylinder owing to the setting or disposition aforesaid of the drying surfaces is subjected to a very considerable variety of movement, whereby a complete disturbance and distribution of the material is effected during its passage through the cylinder the material, being delivered in a dried condition from the lower or outlet end of the inclined cylinder. (*Sealed.*)

MOTOR ROAD VEHICLES.

218,714. Armstrong Siddeley Motors, Limited, Coventry, and H. M. Bonnaud, Coventry. Vehicles having Self-laying Tracks. (2 *Figs.*) December 21, 1923.—The invention relates to the steering of vehicles having self-laying tracks of the kind wherein the track is bent in a horizontal plane to effect the steering, the front end of the track passing round an idler carried upon a horn which is pivoted about a vertical axis to the body or frame of the vehicle. According to



this invention, the track A, in addition to passing round the idler B on the horn C, passes beneath a pair of jockeys G, G2 carried by the horn, one of which, G, is arranged in front and the other, G2, behind the vertical pivotal axis D of the horn. These jockeys are arranged to hold the track upon the ground, and there may be an additional jockey F, between these and the idler at a point where the track does not normally make contact with the ground. (*Sealed.*)

219,813. W. J. Lewin, Hunslet, Leeds, and Deighton's Patent Flue and Tube Company, Limited, Hunslet, Leeds. Motor-Wagon Gulley Emptying and Recharging Apparatus. (3 *Figs.*) July 20, 1923.—The invention relates to that type of motor-wagon gulley emptying and recharging apparatus in which the frame 1 of the wagon is provided with a tank 2 divided by a partition 9 into the upper and lower compartments 6, 7, and in which the upper compartment 6 receives the contents of the gulley from a superposed vacuum casing 3, while the lower compartment 7 contains water or disinfectant to be supplied to the gulley. According to the invention, the frame 1 of the wagon is provided with a permanently fixed two-part tank 2 of rectangular formation as before; but, instead of the partition 9

Fig. 1.

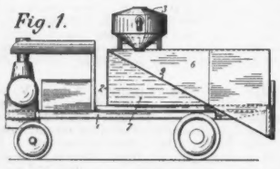
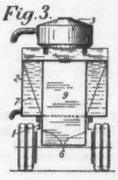


Fig. 3.



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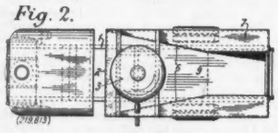


being inclined only slightly in the direction of its length, the partition is made in the form of a chute extending from the top front end of the tank to a point well below the wagon frame at the back end of the tank so as to constitute an upper compartment whose front portion is of taper form in plan, while its back portion passes down between the side frames of the wagon and is of parallel form in plan. In this way the upper compartment of the tank is provided with a base of sufficient inclination as to ensure the emptying of the contents by gravitation, thus materially facilitating the operation. The sides of the tank outside the upper compartment constitute a part of the lower compartment 7, and thus the capacity of either compartment is in no way diminished. (*Sealed.*)

220,022. David Bridge and Co., Limited, Castleton, near Manchester. (*J. Kearns, Conshohocken Pa., and W. Y. Duncan, Jun., Conshohocken Pa., U.S.A.*) **Making India-rubber Tyres.** (2 *Figs.*) February 10, 1923.—The invention relates to mould-closing devices for use in the manufacture of pneumatic tyres for road vehicles. In accordance with the invention, a cylinder *a* is slung from the hook of hoisting and conveying means. The piston *b* is attached by a universal joint with a cross-head *f*. The cross-head *f* extends over the

Fig. 1.

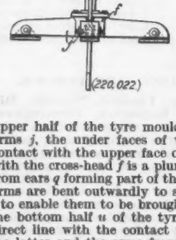
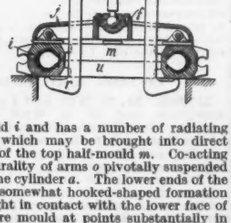


Fig. 2.



upper half of the tyre mould *i* and has a number of radiating arms *j*, the under faces of which may be brought into direct contact with the upper face of the top half-mould *m*. Co-acting with the cross-head *f* is a plurality of arms *o* pivotally suspended from ears *q* forming part of the cylinder *a*. The lower ends of the arms are bent outwardly to somewhat hooked-shaped formation *r* to enable them to be brought in contact with the lower face of the bottom half *u* of the tyre mould at points substantially in direct line with the contact portions of the cross-head, so that the latter and the arms from a clamp or closing device for the tyre mould when pressure is applied to one side of the piston, whilst when pressure is relieved on that side and applied to the other the clamp is released from the mould. (*Sealed.*)

STEAM ENGINES, BOILERS, EVAPORATORS, &c.

219,073. Aveling & Porter, Limited, Rochester, and T. L. Aveling, Rochester. Steam Boilers. (3 *Figs.*) April 14, 1923.—The invention relates to boilers having a firebox of the Belpaire type in which the boiler has a foundation frame to which the boiler plates are riveted and a corrugated plate forming the crown of the boiler, and has bent-over edges which are riveted to the ends of the firebox plates. *a* are firebox plates having machined edges which are jig drilled and have bent over top ends to which is secured a corrugated plate *c* forming the crown and sides of the firebox. *d* is a frame to which the fire-box plates *a* and the shell plates *e* are secured after the crown and side plate *c* has been riveted to the plates *a*. Corresponding

Fig. 1.

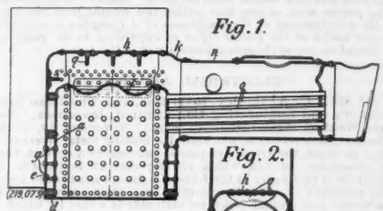
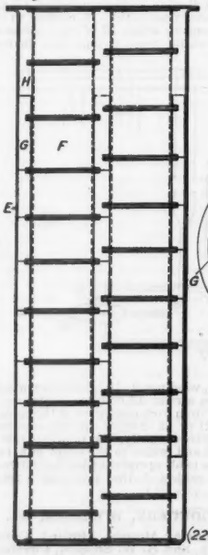


Fig. 2.

stay holes are then tapped in both sets of plates *a* and *e* and are fitted with stays *g*. The roof of the outer shell consists of a plate *h* having machined edges and whose sides are secured to the bent-over tops of the plates *e* and to the plate *k*, the plates *k* being secured to plates *n* surrounding the boiler tubes *c*. The other sides of the roof plate *h* are bent over and secured to the side plates *e* of the shell. Transverse bars *q* of T section and having stems of segmental form, as shown in Fig. 2, are secured to the roof plate *h*. Similar bars *s* are secured to the top of the front plates *e* and T-shaped bars *v* are secured to the side plates of the shell below the joints of the side plates and the roof. (*Sealed.*)

220,175. E. Watson, Dewsbury. Steam Boilers. (4 *Figs.*) August 25, 1923.—The invention relates to Lancashire, Yorkshire and Cornish steam boilers provided with means for preventing what are known as "dead ends." According to the invention, the lower portion J of the water in Lancashire, Yorkshire and Cornish boilers is separated from the upper portion K by means of plates G, which serve as midfeathers or baffles. These plates G run longitudinally of the boiler between the furnace tubes F and between the latter and the boiler shell E, but they are discontinued a suitable distance from each end of the boiler so as to leave a space H at their parts for water connection between the upper and the lower portions J, K. The plates G may be detachable and rest upon arms secured to the flanges of the furnace tubes F, or they may rest upon angle irons secured

Fig. 1.



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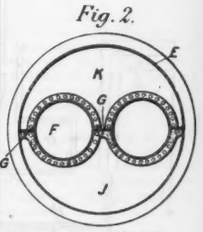

Fig. 3.

Fig. 4.

to the sides of the furnace tubes correspondingly longitudinally thereto, or they may be riveted to these angle irons so as to be integral therewith, as desired, or secured in any other manner, and are adapted to be attached to existing boilers, or during the construction thereof. In steam boilers fitted with the invention the water around and above the fires at the front part of the boiler, is the first to increase in temperature, therefore it rises in front and is replaced by the water from the lower stratum nearest the boiler front. The water passing into the upper stratum is compelled to travel the whole length of the boiler before it can return down through the space H at the back of the boiler, into the lower stratum. In this manner a continuous circulation of the water over and under the plates G takes place. (*Accepted August* 20, 1924.)